Vic-3D 2010

Reference Manual

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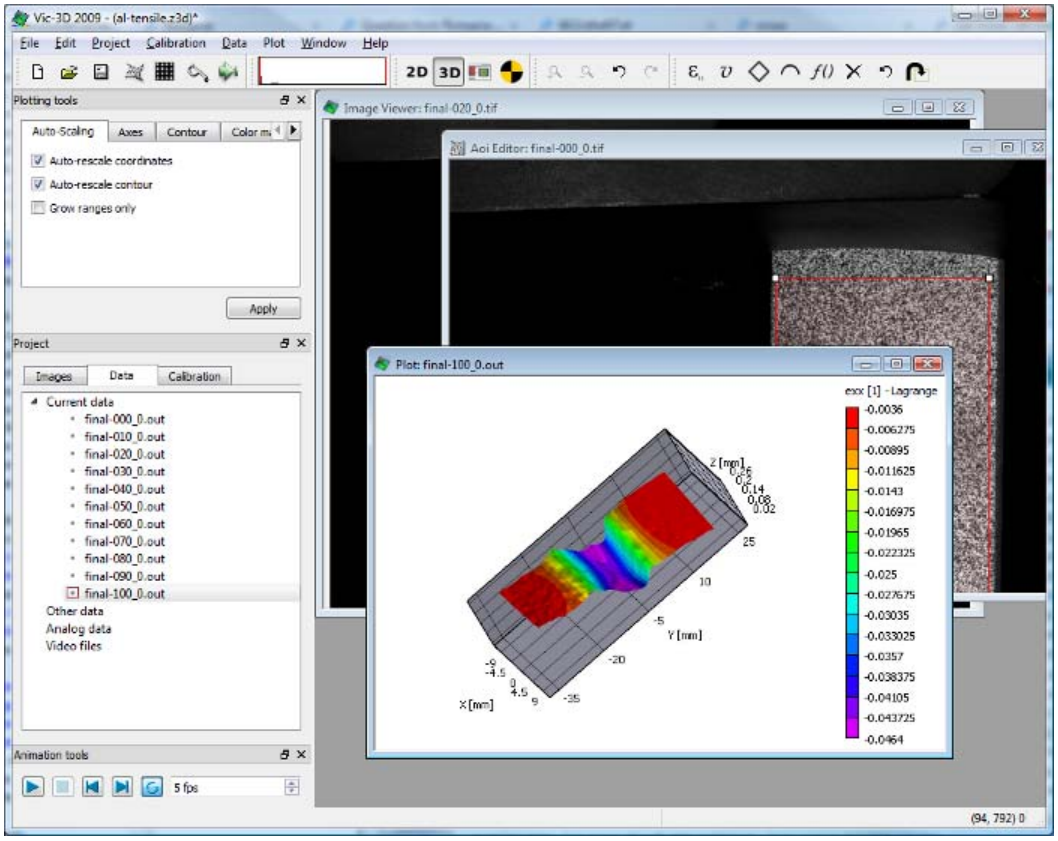
Overview

The user interface of Vic-3D has many of the familiar control elements found in other applications. The image below illustrates the user interface. The most commonly used functions can be accessed by clicking on tool buttons on the **Tool Bar**. The windows, such as the **Reference Window** and **3D Plot** windows are grouped inside a **Workspace**. The **List View** on the left of the main window provides a quick overview of image and data files.



File Menu

The *File Menu* provides the following functions:

- **New** - creates a new project
- **Open** - open an existing project
- **Save** - save the current project
- **Save As...** - save the current project under a new file name
- **Mode** - select a Vic-3D project type (3D, realtime, stereomicroscope, etc)
- **Install module licenses** - use this menu entry to activate software modules you have purchased
- **Quit** - quit Vic-3D

Edit Menu

The *Edit Menu* provides the following functions:

- **Undo** - undo the last editing operation in the reference image
- **Redo** - redo the last editing operation in the reference image
- **AOI tools** - each AOI tool is selectable from this menu.

Project Menu

The *Project Menu* provides the following functions:

- **Speckle images**- adds speckle images to the project for analysis
- **Calibration images** - adds calibration images to the project.
- **Speckle image groups** - add a group of speckle images with the same prefix

- **Calibration image groups -** add a group of calibration images with the same prefix
- **Data files** - adds pre-existing output data files to the project
- **Analog data** - adds analog data files from Vic-Snap
- **Video clip** - adds generated AVI files
- **Workspace** - displays the 3D image correlation workspace
- **Marker editor** - displays the marker tracking toolset

Calibration Menu

The *Calibration Menu* provides the following functions:

- **Calibrate stereo system** - calibrates the cameras and stereo rig simultaneously
- **From project file** - import a calibration from an existing Z3D or V3D project file
- **Autocorrect calibration** - corrects for a disturbed camera orientation calibration
- **Adjust for cropping** - adjusts for differently sized calibration vs. speckle images
- **Calibrate camera 1 / 2** - calibrates camera parameters separately
- **Calibrate camera orientation** - calibrates stereo transformation separately
- **Calibrate external camera** - calibrate for overlay of auxiliary camera data (i.e., from an infrared camera)

Data Menu

The *Data Menu* provides the following functions:

- **Start analysis** - shows the Run dialog to begin 3D analysis
- **Postprocessing tools** - shows a submenu to choose from various postprocessing calculations
- **Coordinate tools** - shows a submenu to allow coordinate system manipulation
- **Markers** - allows exporting or fitting coordinates to marker data
- **Export** - various options for exporting full data set or reductions

Plot Menu

The *Plot Menu* provides the following functions:

- **New plot**- adds a new plot window to the work space
- **2D Plot**- changes the currently selected plot to 2D overlay mode
- **3D Plot**- changes the currently selected plot to 3D plot mode
- **Inspector**- allows choice of various data inspection tools

Window Menu

The *Window Menu* provides the following functions:

- **Cascade** - organizes all MDI windows in a cascade
- **Tile** - tiles all MDI windows

Help Menu

The *Help Menu* provides the following functions:

- **User manual** - show this manual.
- **About** - show version information.

Main Toolbar

The buttons on the main toolbar control commonly used Vic-3D functions. From left to right:

File tools:

- New project
- Open project
- Save project
- Add speckle images
- Add calibration images

- Calibrate stereo system (click and hold for automatic calibration)
- Start analysis

Histogram control

Plotting tools:

- Switch to 2D plot/3D plot
- Workspace
- Marker tools
- Zoom in/out
- Undo/redo

Postprocessing tools:

- Calculate strain
- Calculate velocity
- Calculate in-plane rotation
- Calculate curvature
- Apply a custom function
- Remove variables
- Retriangulate data
- Remove rigid motion

The histogram control displays the gray level distribution for the currently displayed image. The red bars on the histogram may be used to adjust the image display. Double-click on the histogram to automatically adjust the balance, or drag the red bars to set the black and white levels manually. Double click again to remove the balance adjustment.

The balance control is for display only and does not affect image analysis or stored images.

Animation Toolbar

The buttons on the animation toolbar allow stepping through and animating image files or plots. The controls, from left to right:

- **Play** - begins automatically stepping through images/plots.
- **Stop** - stops the animation.
- **Step Back / Step Forward** - goes to previous or next image/plot.
- **Loop** - toggles between looping from last image to first, and bouncing from forward to backward animation.
- **Frame rate** - selects the speed of the animation..

Other Functionality

In the right corner of the status bar at the bottom of the main window, the cursor position and image grey value is displayed when the mouse is moved inside the reference image or a deformed image. For 2D plots, this area will show the 3D coordinates as well as the value of the current contour variable. On the left side of the status bar, a short description of tool buttons and menu items is displayed when the mouse moves over them.

In the list view on the left side of the main window, some functions can be activated by right-clicking. Details can be found in the appropriate sections of this menu.

The Start Page

The start page in Vic-3D gives convenient access to frequently-used tasks, recent projects, and project type selection.

Common Tasks

This section duplicates common tasks from the menu bar. Click to open a project, add speckle or calibration images, or view this user manual.

Recent Files

This section contains a list of the most recently accessed projects. Click on a filename to open the project.

Projects in Vic-3D

In Vic-3D, all the files and information associated with a test are stored in a *project*.

Initially, projects are blank. Before completing a Vic-3D analysis, the project must contain:

- One or more speckle images , including a reference image
- A set of calibration images
- A calibration
- One or more areas of interest

Note: Adding speckle and calibration images to the project adds them by filename reference only; they are not copied or moved on the disk.

When you run a Vic-3D analysis, the output files are stored on a disk and added (by reference) to the project file. If the project file is not saved or if the data files are manually removed, they will remain on the disk.

In addition to the items above, you can also choose to add auxiliary data references to the project file:

- Generated video clips
- Analog data files from Vic-Snap

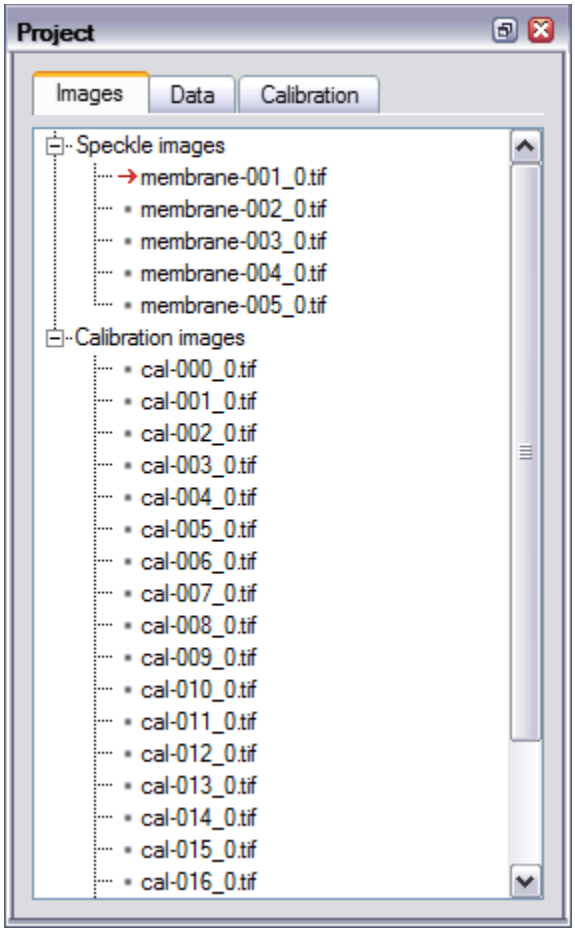
Notes

- In general, it's good practice to save project files often to avoid losing changes.
- Vic-3D 2009 uses a new .z3d project file format. Older .v3d files may be opened, but not saved.
- Once a calibration is performed and saved in the project file, the calibration images may be discarded if desired. All the data calculated in the calibration routine is stored numerically in the project file.

The Project Toolbar

The plot toolbar is displayed at the left side of the work area by default. It contains information about image files, data, and calibration for the current project.

The Images Tab



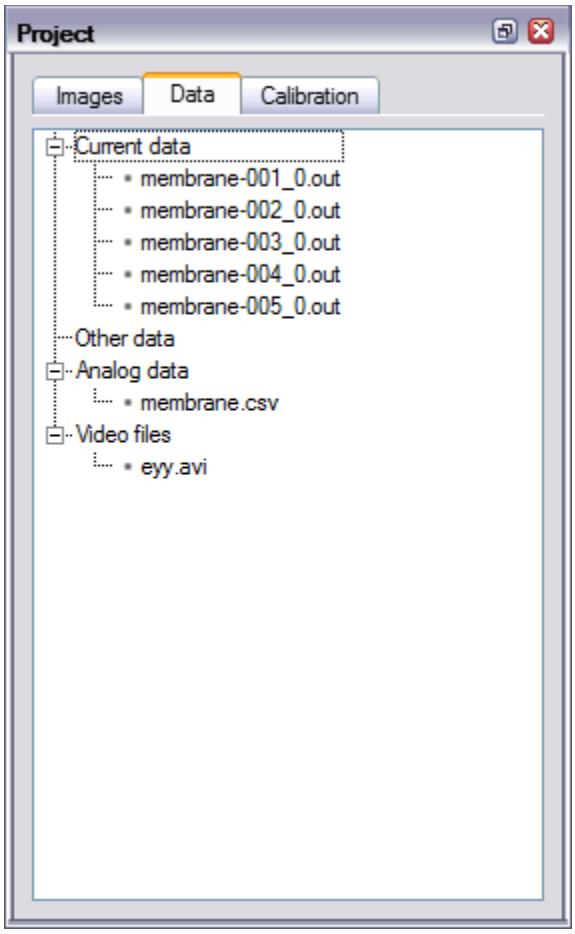
This tab shows all speckle and calibration images associated with the project.

To add speckle images, select *Images... Speckle images* from the menu bar, or click the speckle images icon on the main toolbar. The small red arrow indicates the reference image; to set an image as the reference, right click and click *Set as reference* .

To add calibration images, select *Images... Calibration images* from the menu bar, or click the calibration images icon on the main toolbar .

To remove an image or series of images, select them, right click, and click *Remove* or *Remove selected* .

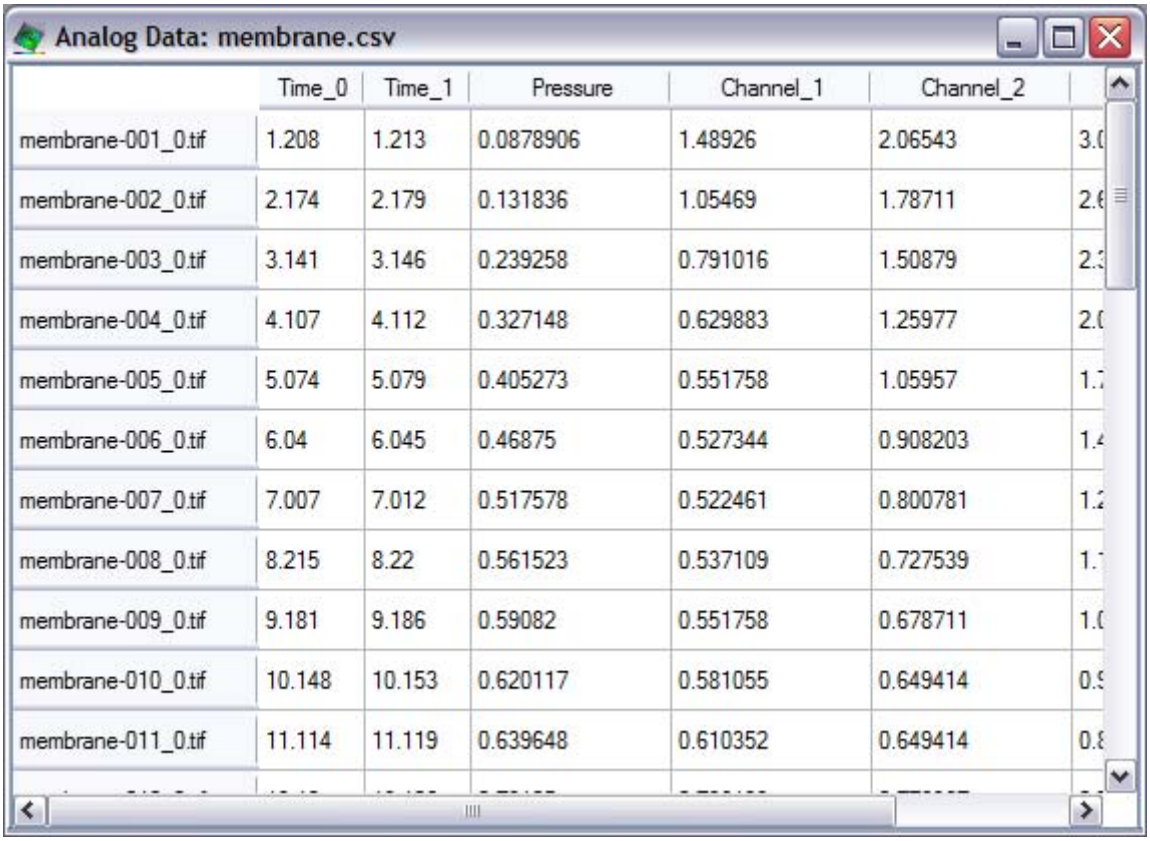
The Data Tab



The Data tab lists all output data, analog data, and video files associated with the project.

All generated output files are added to the *Current data* list. Output files not associated with current speckle images are added to *Other data*. Double-click on a data file to view a 3D plot.

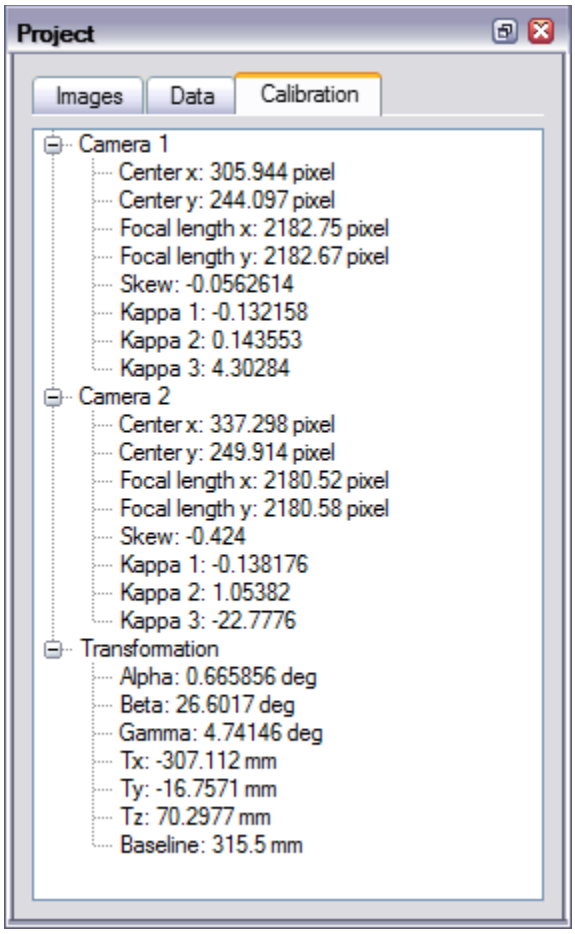
Analog data from Vic-Snap is listed under *Analog data*. To add an analog data file, select *File... Add Files... Add Data Files* from the main menu. To view a spreadsheet of the data, double-click the filename.



	Time_0	Time_1	Pressure	Channel_1	Channel_2	
membrane-001_0.tif	1.208	1.213	0.0878906	1.48926	2.06543	3.(
membrane-002_0.tif	2.174	2.179	0.131836	1.05469	1.78711	2.6
membrane-003_0.tif	3.141	3.146	0.239258	0.791016	1.50879	2.3
membrane-004_0.tif	4.107	4.112	0.327148	0.629883	1.25977	2.(
membrane-005_0.tif	5.074	5.079	0.405273	0.551758	1.05957	1.7
membrane-006_0.tif	6.04	6.045	0.46875	0.527344	0.908203	1.4
membrane-007_0.tif	7.007	7.012	0.517578	0.522461	0.800781	1.2
membrane-008_0.tif	8.215	8.22	0.561523	0.537109	0.727539	1.1
membrane-009_0.tif	9.181	9.186	0.59082	0.551758	0.678711	1.(
membrane-010_0.tif	10.148	10.153	0.620117	0.581055	0.649414	0.9
membrane-011_0.tif	11.114	11.119	0.639648	0.610352	0.649414	0.8

Generated video files from 2D and 3D animations are added to the *Video files* list. Double-click on a video to display it in an external viewer.

The Calibration Tab



This tab is a static display of the current calibration information for the project.

Intrinsic parameters are displayed for each camera:

- sensor center
- focal length (in pixels)
- skew
- 1, 2, or 3 radial distortion coefficients, depending on selected order

Extrinsic parameters are displayed for the stereo rig:

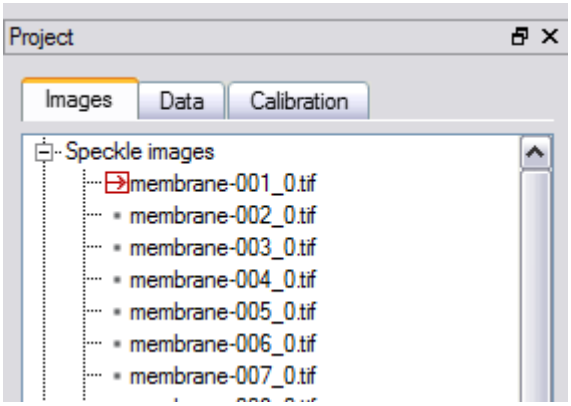
- Alpha (rotation about the optical axis)
- Beta (stereo angle)
- Gamma (tilt)
- Tx, Ty, Tz: relative translation of camera 1
- Baseline: distance between cameras (resultant of Tx, Ty, Tz)

Speckle Images

In Vic-3D, speckle images are image or set of images taken of a specimen as it undergoes load or motion. You may add one or multiple speckle images by selecting the *Speckle images* entry from the *Project* menu, or by clicking the icon on the main tool bar .

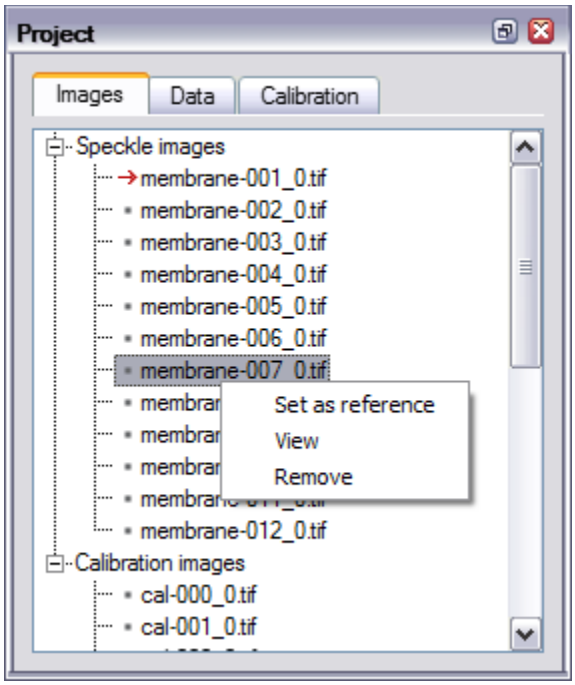
If more than 300-400 images are to be added, select *Project... Speckle image groups* to add sets of images from a specified folder. Select a folder to see a checklist of image prefix groups; select one or more to add as speckle images. (Trying to add too many images directly through the normal *Speckle images* dialog may result in an error due to operating system limitations.)

After adding speckle images to the project, they will be displayed in the workspace and listed in the *Images* tab of the project bar as shown in the figure below.



Viewing Images

Deformed images can be displayed in the workspace by double-clicking on an entry in the image list view. Alternatively, clicking the right mouse button on an entry of the list view will show a popup menu providing different options, one of which is *View* .



When viewing deformed images, you can use the zoom in/zoom out entries in the *Edit* menu or the corresponding tool buttons to change the scale of the displayed image.

Animating Images

To animate speckle images, display an image and then use the controls on the Animation Toolbar to animate the sequence.

Changing between cameras

To change between the two cameras of the stereo-system, right-click on the image viewer. A popup menu will be displayed as shown in Figure 3 allowing to change between the images taken by the two cameras.

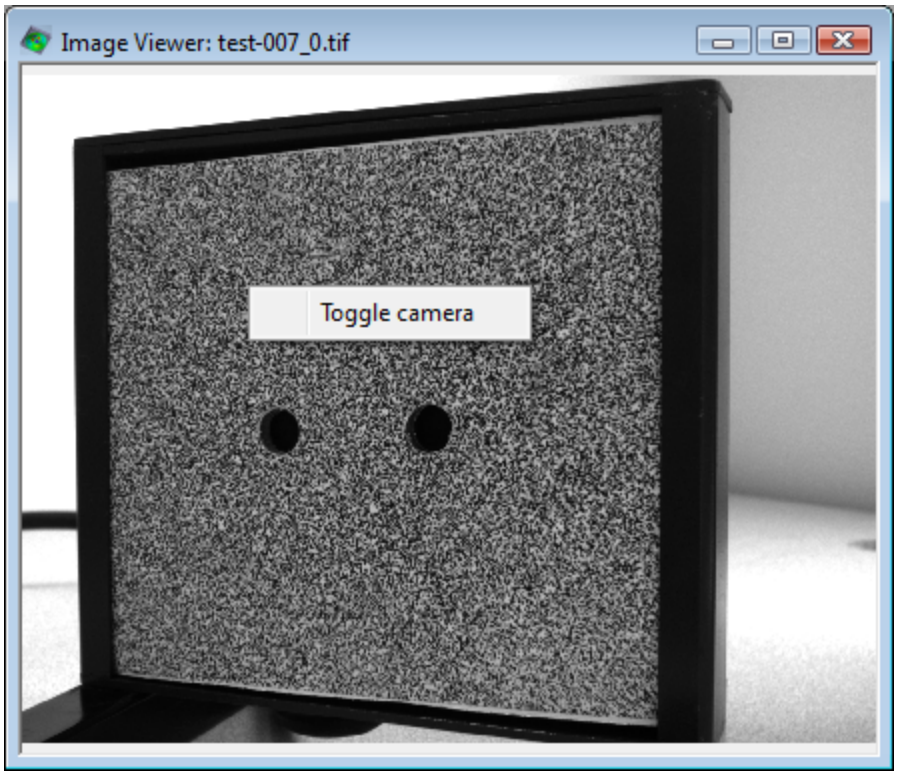


Figure 3: Right-button menu in image viewer.

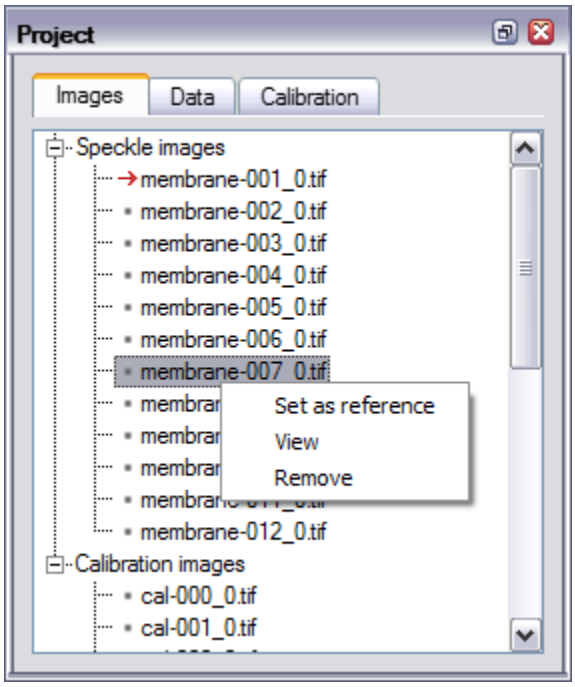
Removing Images

Calibration images can be removed by selecting one or multiple images in the list view, and right-clicking on your selection. Select *Remove* or *Remove selected* to remove images from the list.

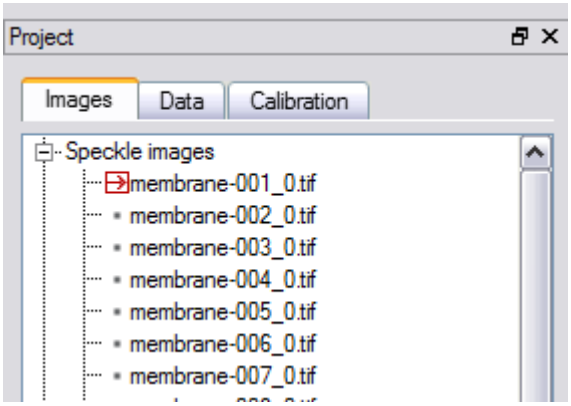
The Reference Image

The term *Reference Image* is used in this manual to describe the image of the specimen taken while no load was applied. All displacement analyses in Vic-3D are with respect to this reference image, i.e., the displacements are obtained in a Lagrangian coordinate system.

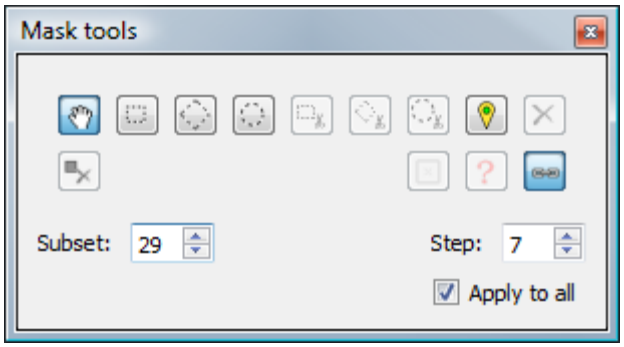
To select a reference image, right-click on it in the Speckle images list, and select *Set as reference.*



After the reference image has been selected, it will be indicated with a red arrow in the images list.



When the reference image is displayed, the mask tool buttons become active.



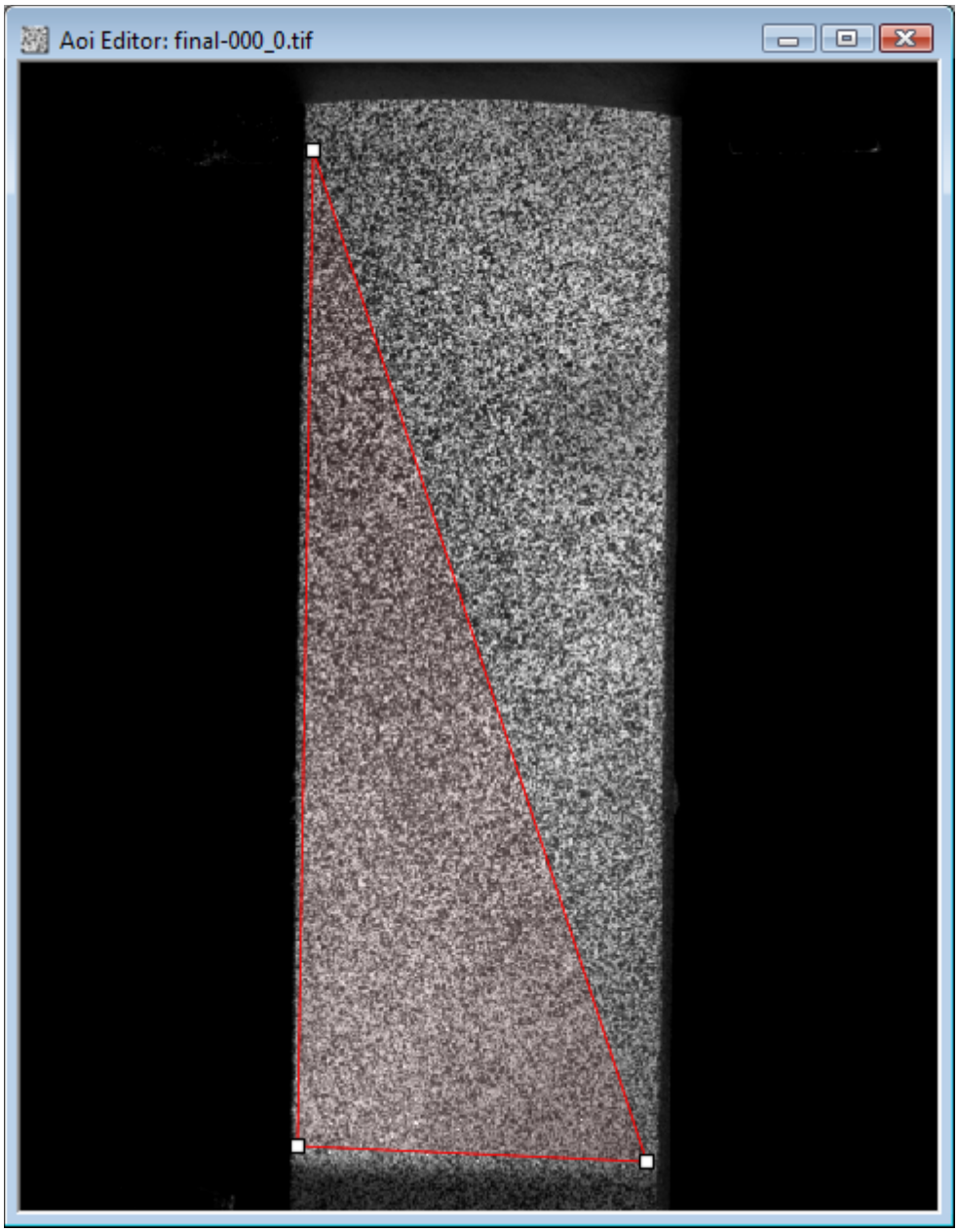
Selecting an Area-of-Interest

Vic-3D supports the following types of AOIs:

- **Rectangle:** Points are contained in a rectangular area.
- **Polygon:** Points are contained in an arbitrary polygon.
- **Circle:** Automatically creates a roughly circular polygon.

To specify a particular type of AOI, select the corresponding entry in the *Edit* menu or the appropriate button on the tool bar. The selected AOI type will be indicated by the mouse cursor.

After selecting the AOI type, move the cursor to the desired position in the reference window and click the left mouse button. You can now move the mouse to the next position, e.g. the end of the line or the second corner of the rectangle. Clicking the left mouse button again will complete the AOI selection for all AOI types except polygons. For polygon selection, a double-click is used to specify the last point of the polygon.



Editing AOIs

To edit an existing AOI, select the Pan/Select tool. Mouse over any of the white nodes in your AOI; the mouse cursor changes to indicate node movement. Click and drag to move. You can delete a node by clicking the icon, then clicking the desired node.

If the merge polygons icon ( ) is selected, any overlapping polygons will be merged with each other. If the icon is not selected, overlapping AOIs will remain separate.

Cutouts

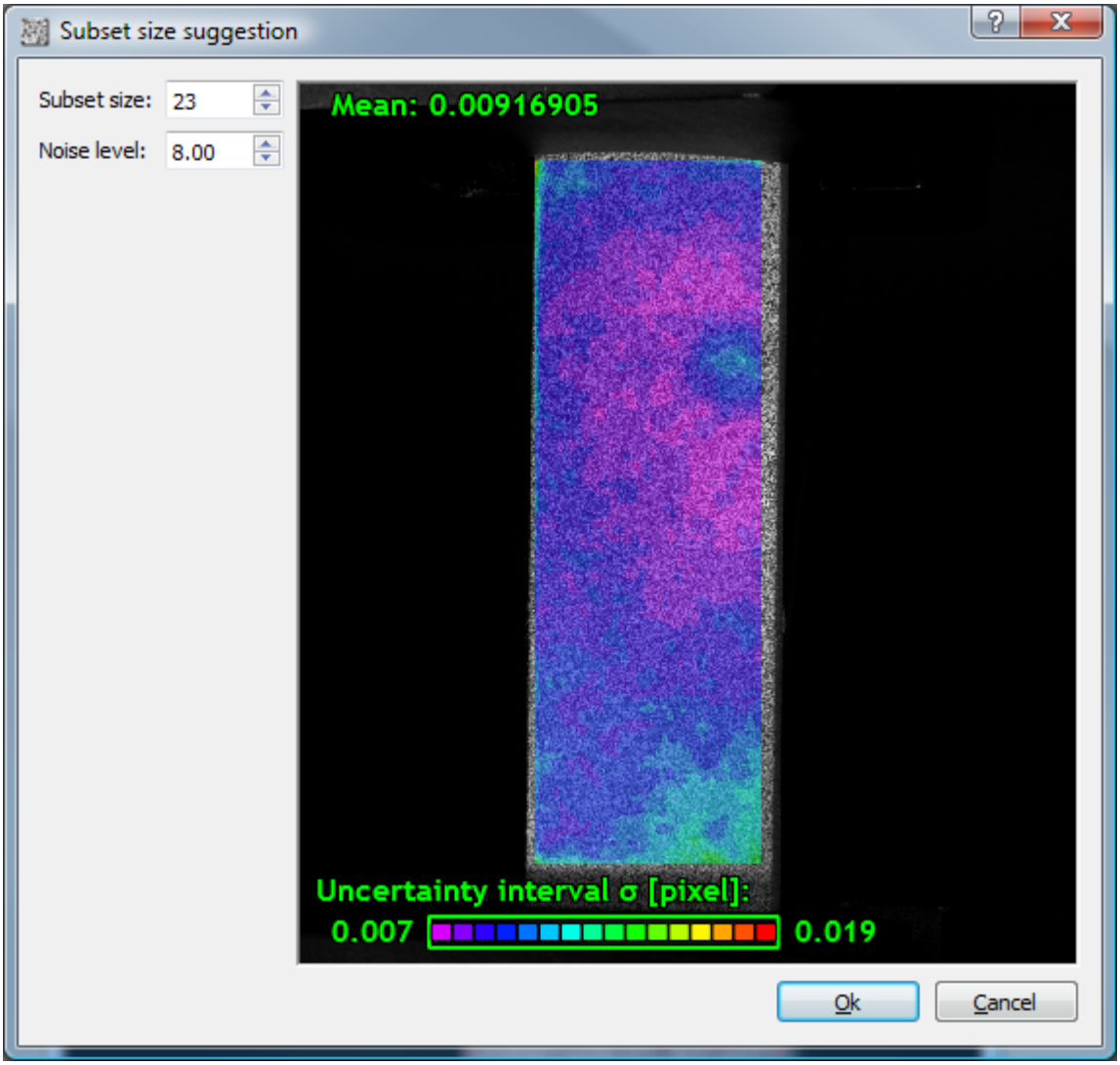
For rectangular and polygon AOIs, the scissors tool can be used to cut areas from the AOI. This feature is most commonly used if the specimen has cracks, holes, or other areas where correlation is impossible.

To cut an area from an AOI, click the scissors button on the tool bar or select *Edit... Cut region*. The selection of the area to be cut works like selecting a polygon AOI, i.e., corner points of a polygon can be added by single-clicking the left mouse button, and the last point is specified by a double-click. Once the cut is complete, new nodes are added to your AOI; these may be moved like other nodes.

Choosing the Subset and Step Size

The subset and step size can be selected after an area of interest is created. Both are adjusted using the spin boxes in the AOI Toolbar.

The subset size controls the area of the image that is used to track the displacement between images. The subset size has to be large enough to ensure that there is a sufficiently distinctive pattern contained in the area used for correlation. If you change the subset size, you will see the current size illustrated by a grid briefly displayed on the AOI. To have Vic-3D suggest a subset size, click the ? icon:



Vic-3D will choose a subset size which is calculated to give an optimal match confidence of 0.01 pixel for a given assumed noise level. The default of 8 works well for most cameras. To accept the suggested

size, click **Ok**; to return without making a change, click **Cancel**.

The step size controls the spacing of the points that are analyzed during correlation. If a step size of 1 is chosen, a correlation analysis is performed at every pixel inside the area-of-interest. A step size of 2 means that a correlation will be carried out at every other pixel in both the horizontal and vertical direction, etc. Note that analysis time varies inversely with the square of the step size; i.e., a step size of 1 takes 25 times longer to analyze than a step size of 5.

To cause subset and step size changes to apply to every AOI, check the *Apply to all* box. If this box is cleared, subsets and steps can vary between AOIs.

Placing start points

In some situations, start points may be need for the correlation. To place a start point, click the icon. The Initial Guess Selection page has more information about selecting end editing start points.

To remove a start point, click the icon, then click the start point.

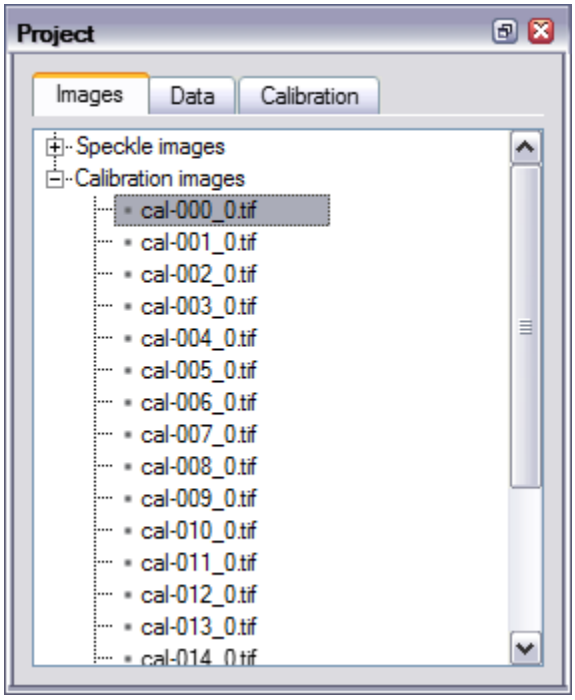
Hints

- Use the scroll wheel to adjust the size of the image.
- When using multiple AOIs for one image, click on an AOI with the pan/select tool to activate it.
- During AOI selection, the image can be scrolled by moving the mouse outside the reference image window. This will cause the image to autoscroll if the image does not fit on the display.
- You can use the Undo/Redo buttons to undo AOI selection and other operations. The Undo/Redo buttons in the *Edit* menu will indicate what changes can be undone/redone.

Calibration Images

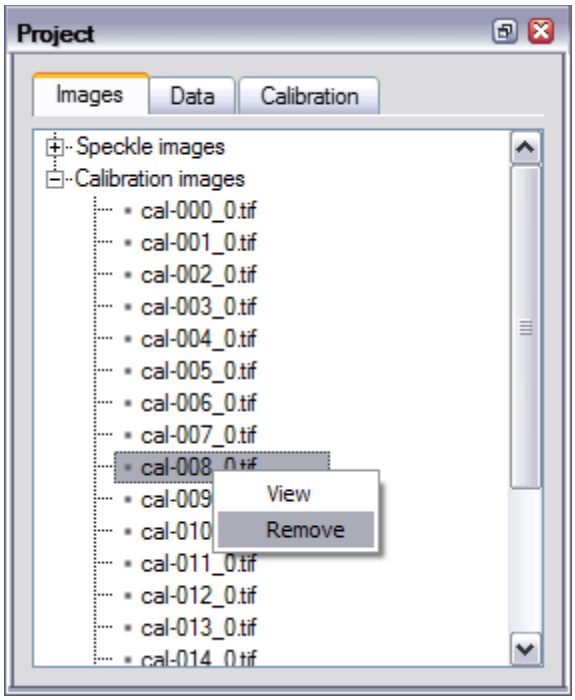
Calibration images can be added by selecting the *Calibration images* entry from the *Images* menu, or by clicking the icon on the main tool bar .

After adding calibration images to the project, they will be listed in the *Images* tab of the project bar, as illustrated below.



Viewing Images

Calibration images can be displayed in the workspace by double-clicking on an entry in the list view on the left. Alternatively, clicking the right mouse button on an entry of the list view will show a popup menu providing different options, one of which is *View*.



When viewing calibration images, you can use the zoom in/zoom out entries in the *Edit* menu or the corresponding tool buttons to change the scale of the displayed image.

Changing between cameras

To change between the two cameras of the stereo-system, right-click on the image viewer. A popup menu will be displayed as shown in Figure 3 allowing to change between the images taken by the two cameras.

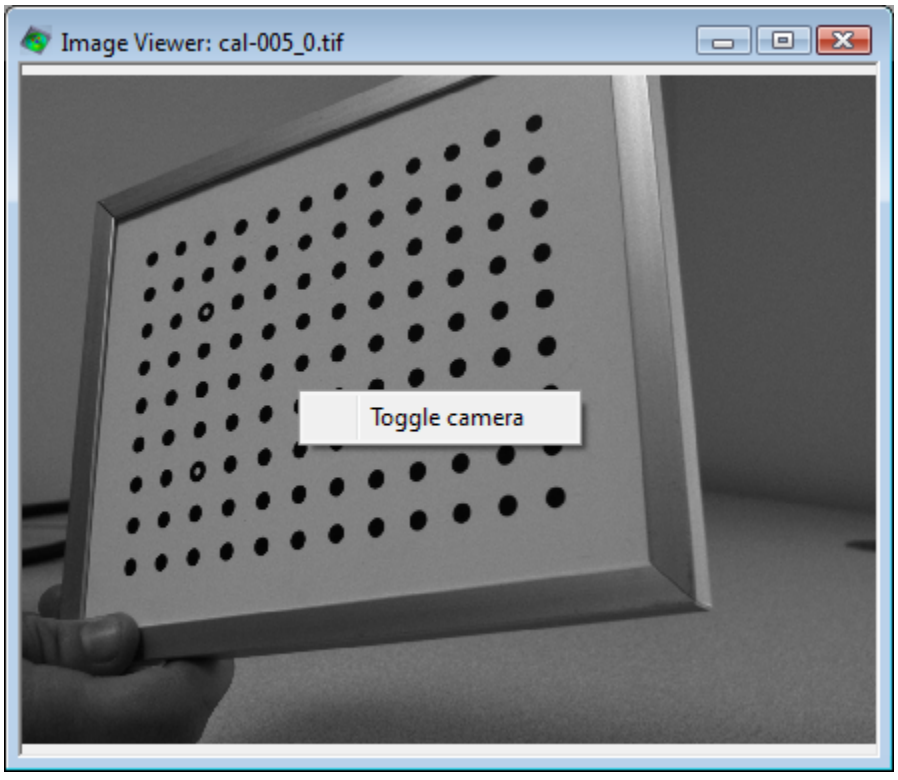


Figure 3: Right-button menu in image viewer.

Removing Calibration Images

Calibration images can be removed by selecting one or multiple images in the list view, and right-clicking on your selection. Select *Remove* or *Remove selected* to remove images from the list.

Calibration

Calibration can be accomplished either through a stereo calibration - where intrinsic and extrinsic parameters are calculated together - or a separate calibration.

Stereo Calibration

For most applications, stereo calibration is used. The calibration target is imaged simultaneously in both cameras, and the synchronized target images are used to fully calibrate the system in one step.

Separate Calibration

In certain applications, a stereo calibration is not practical. In this case a separate calibration method can be used.

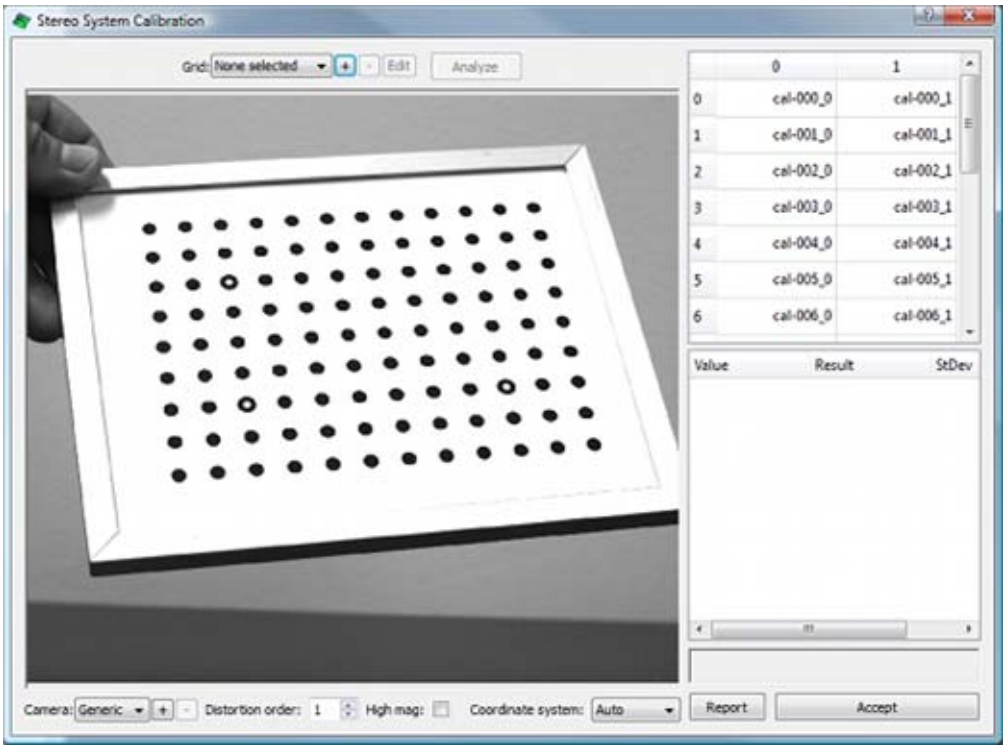
In this method, each camera acquires target images separately. These images are used to calculate intrinsic parameters for the cameras. A static speckle image is then used to establish the camera orientation. For this method, the speckle image must contain markers or fiducial points with a known distance between them.

Cases where separate calibration will be useful include:

- Very large fields of view
- Cameras that cannot be synchronized
- Cameras that must be moved after calibration
- Certain complex mirror setups

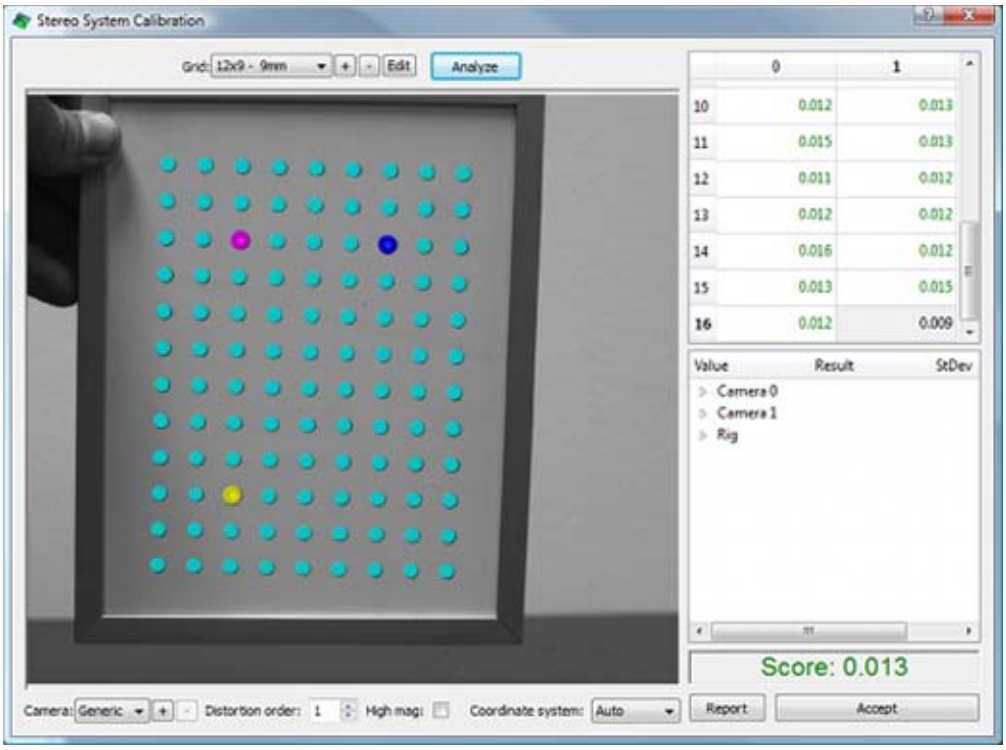
Stereo Calibration

To begin, select the *Calibrate stereo system* entry from the *Calibration* menu, or click on the icon on the tool bar. The calibration dialog will appear:



Select the grid you used from the **Grid:** pulldown, and click **Analyze** to process the images and calibrate.

Vic-3D will go through each image and extract the dot centers; once image analysis is complete, the calibration will be computed. If the score is higher than optimal, any outlying images will be discarded and the calibration computed again. The final; score (in pixels; lower is better) is displayed in the bottom right.



Click **Accept** to use this calibration.

Results in Detail

For each image, a score is displayed. This is the average error (in pixels) between the position where a target point was found in the image, and the theoretical position where the mathematical calibration model places the point. Good scores will be displayed in green; higher scores will be red. To remove a certain image from the calibration, you can right-click on it and select **Remove Points**. To use points from an image which has been cleared, right-click again and select **Extract**.

Calculated calibration values are displayed in the tree view to the lower right. Each item has a value as well as a +/- confidence interval (one standard deviation).

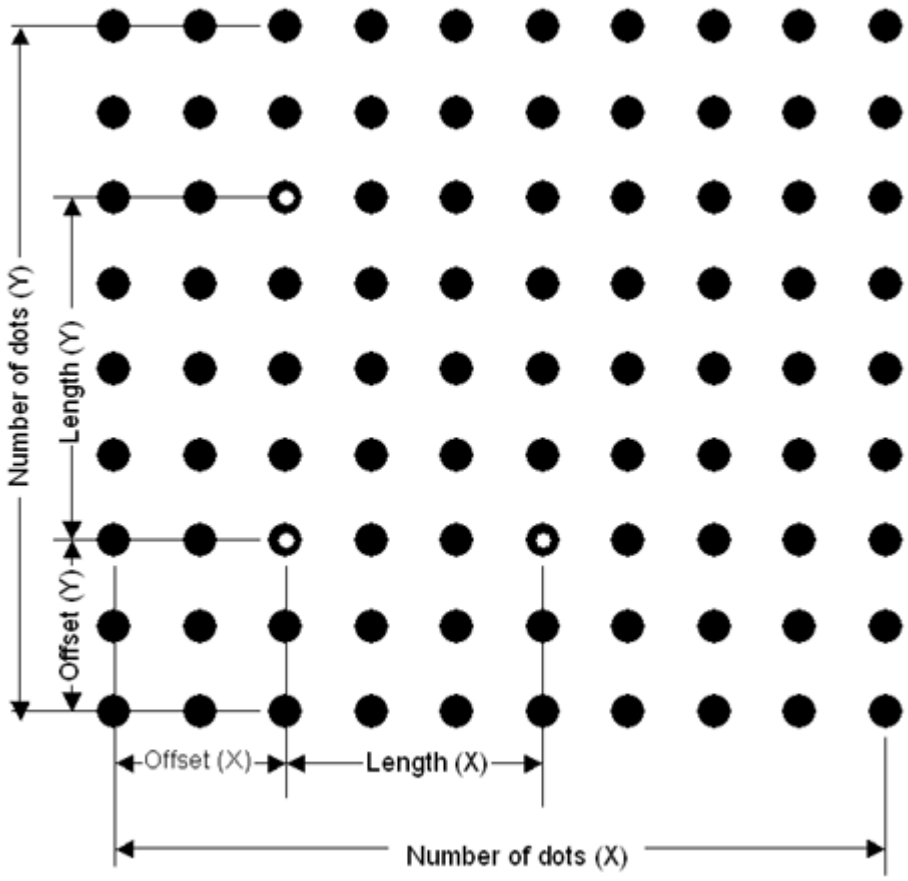
To view a report containing all the information as text, click **Report**. This report can also be copied to the clipboard and saved for later reference.

Grid Selection

If the grid used is not listed in the pulldown, click **+** to add a new one or **Edit** to edit the current settings. When clicking **+**, Vic-3D will attempt to automatically extract the grid information, and will fill it in if found; in this case, only the grid spacing must be entered.

To remove a previously entered grid, select it and click the **-** icon.

The diagram below illustrates the meaning of each grid parameter:



Other Options

To select the camera used in the calibration, select from the pulldown, or click the + to add a new custom camera. You can use this option to specify a fixed aspect ratio and/or skew factor, where these are known. Fixing these parameters can improve the calibration in cases where target motions were limited or where they were poorly estimated.

To specify the distortion order of the lens, use the **Distortion Order** spin box. A value of 1 will work for most lenses but certain shorter lenses will require a distortion order of 2 or 3 to achieve the best score.

For high-magnification situations where the center cannot be well estimated, you can force the center values to the geometric center of the sensor by clicking **High mag**.

To use a certain grid orientation as the XY plane for the results coordinate system, select the relevant image from the **Coordinate system** pulldown. Use the *Auto* selection for a coordinate system centered about the camera rig.

When any of these settings is changed after completing calibration, a new calibration will be computed with the new option applied. You can also change these options before clicking **Analyze** to avoid recomputation.

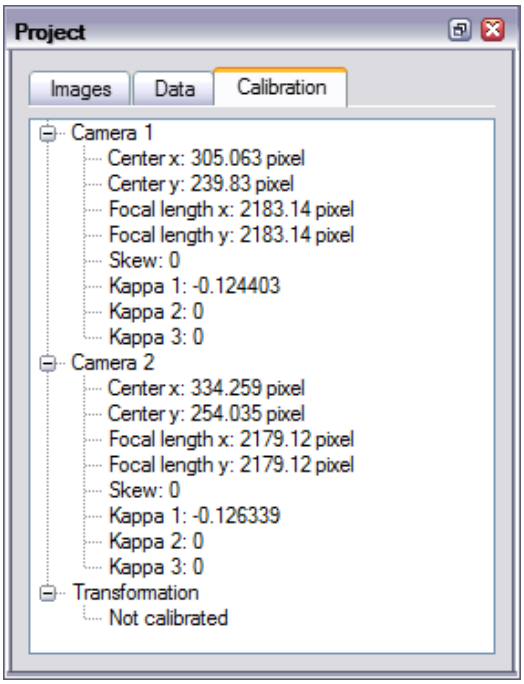
Separate Calibration

In some cases, it may be necessary or advantageous to calibrate the cameras separately - for their intrinsic parameters - followed by calibrating the system's extrinsic parameters. With this method, the cameras are calibrated using a target, and the geometry of the two cameras is determined from a speckle pattern - either a speckle target, or the specimen itself. This method requires that two marker points with a known distance on the specimen surface are present in the images.

To calibrate the camera parameters separately, begin by adding calibration images to the project. **Note:** Vic-3D expects image files for both cameras to be present on the disk, even if only one of the two images is used.

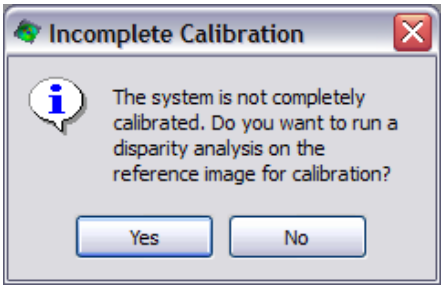
Select *Calibrate... Calibrate Camera 1* from the main menu bar. Proceed through the Calibration Dialog as with stereo calibration; repeat for camera 2.

At this point, each camera is calibrated but the stereo rig transformation is still undetermined; this can be confirmed by viewing the Calibration tab of the project toolbar, as below.



To calibrate the camera orientation, add a reference image to the project and select an area of interest (AOI). Ideally, the AOI should cover as large an area of the image as possible.

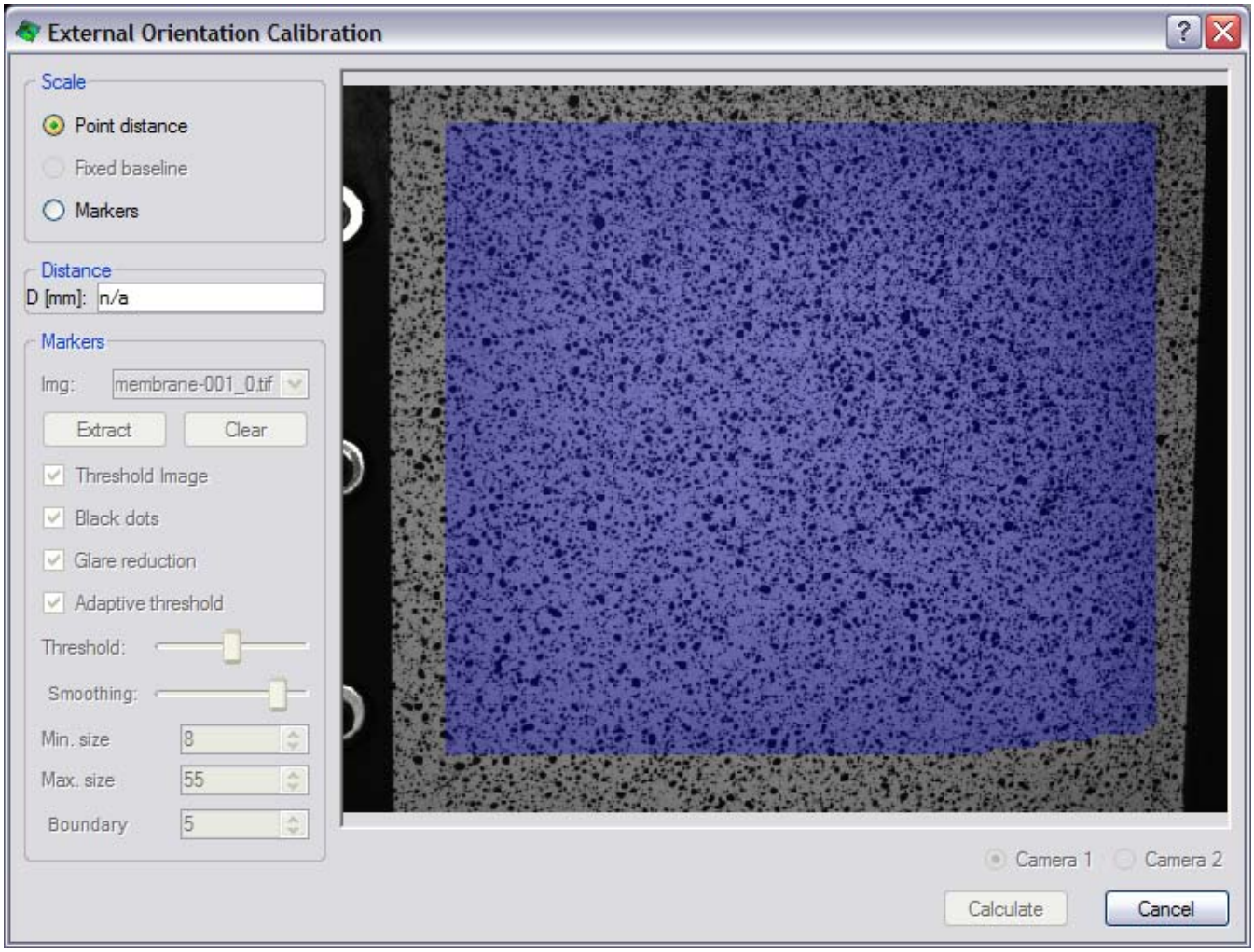
Since the system is not calibrated, you **must** provide an initial guess before beginning the calibration. Then, run the calibration. You will be prompted to run a disparity analysis:


Incomplete Calibration
The system is not completely calibrated. Do you want to run a disparity analysis on the reference image for calibration?
Yes
No

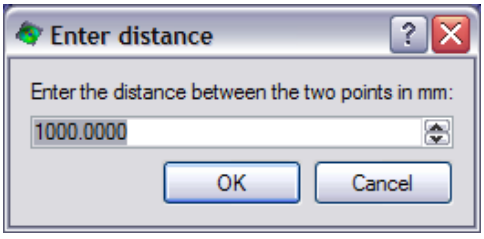
Click Yes to continue or No to cancel. Continuing will run a disparity analysis, where the raw image disparities are

calculated but triangulation is not attempted, and no 3D shape will be calculated.

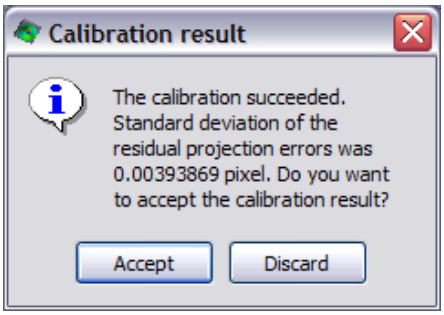
Next, select *Calibrate camera orientation* from the *Calibration* menu. The dialog shown below will appear.



On the displayed image, click and drag select a line between two marker points that are a known distance apart. After selecting the line, the following dialog will appear:



Enter the distance between the two marker points and click *Ok*. You can click *Calculate* to finish the calibration, or change the selected line. On completion, a calibration score will be displayed:


Calibration result
The calibration succeeded. Standard deviation of the residual projection errors was 0.00393869 pixel. Do you want to accept the calibration result?
Accept
Discard

High numbers indicate problems with the underlying data; if necessary, adjust AOI or initial guess and re-run.

Fixed Baseline Calibration

The *Fixed Baseline* option can be used when a stereo calibration is present but has been altered; for example, in a stereo rig where the cameras have been bumped, or disturbed by a very dynamic test. It can also be used in the general case when a correlation results in a higher than expected projection error.

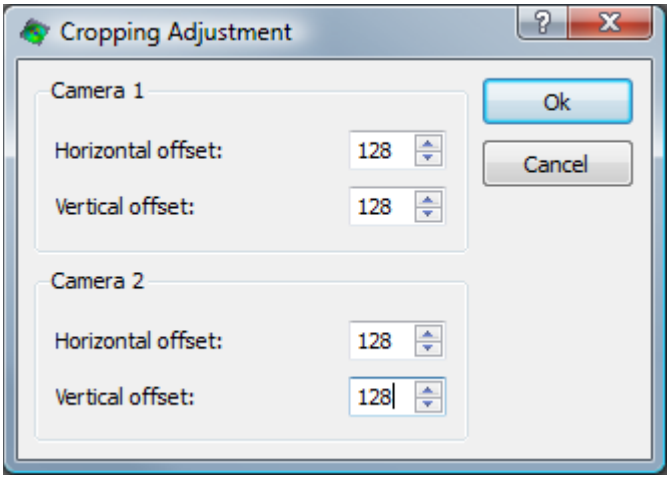
The algorithm works by assuming that the stereo baseline is fixed and that only camera rotation changed. This assumption works well for most systems where the cameras are fixed in space by tripods or bars, but allowed to rotate on their mounts.

To perform this operation, select *Calibrate... Calibrate camera orientation*. Select the *Fixed Baseline* scale option, and click the *Calculate* button. A calibration score will be displayed; to proceed, click *Accept* .

Adjustments for Cropping

For many applications, particularly in high-speed imaging, the images collected during the test may not have been acquired at full sensor resolution in order to increase the frame rate or to save disk space. This can pose serious difficulties for normal calibration procedures. For instance, if a dog-bone sample is used, it can be advantageous to reduce the size of the image in the short dimension of the sample. This can lead to images that are only a few tens of pixels in one dimension, and it is practically impossible to image a calibration target in this case.

For such applications, it is best to calibrate the camera at the full resolution of the sensor and only crop the images during the test. The crop dialog seen in the figure below permits adjustment of the calibration in such cases.



The dialog permits the user to enter the top-left corner of the image section with respect to the calibration images for both cameras.

- If a reference image is loaded during calibration with a different size than the calibration images, the adjustment dialog is automatically shown.
- The default values for the offsets are computed so that they are correct for most modern high-speed cameras that crop from the center of the sensor.
- For images taken with Vic-Snap, the correct values will be read from the TIFF metadata.

Importing a Calibration

To import the calibration from an existing Z3D or V3D project file, select *Calibration... From project file* from the main menu bar. You will be prompted to select a project file; when complete, the calibration will be imported and added to your current project.

Initial Guess Selection

In Vic-3D 2010, initial guesses will be needed very rarely. Some instances where they may still be necessary include:

- Multiple, large camera angles (rather than a single stereo angle)
- Highly curved surfaces such as cylinders
- Large rotations between successive images
- Very fine or indistinct speckle patterns
- Poor calibration.

In the absence of these conditions, you can generally run the correlation immediately after selecting an AOI. If the correlation fails or runs very slowly, an initial guess may be needed.

Changes from older versions

Vic-3D uses a new model for start points which is a bit different than the seed point used in previous versions.

- Not every AOI will have a start point. In many cases you can just draw the AOI and run immediately.
- You can now draw multiple start points. They will be analyzed in parallel and analysis will proceed outwards from each one at the same time.
- Start points are no longer associated with a specific AOI; they can be placed in overlapping AOIs, or completely off the AOI. Start points which are too far from an AOI will not be used for anything.

Placing start points

Generally, it is best to place a start point in the area of the image that undergoes the least amount of motion during the test. For instance, if a specimen is tested in a tensile frame, the start point should be placed as close to the stationary grip as possible. Placing the seed point this way will help ensure fully automatic correlation.

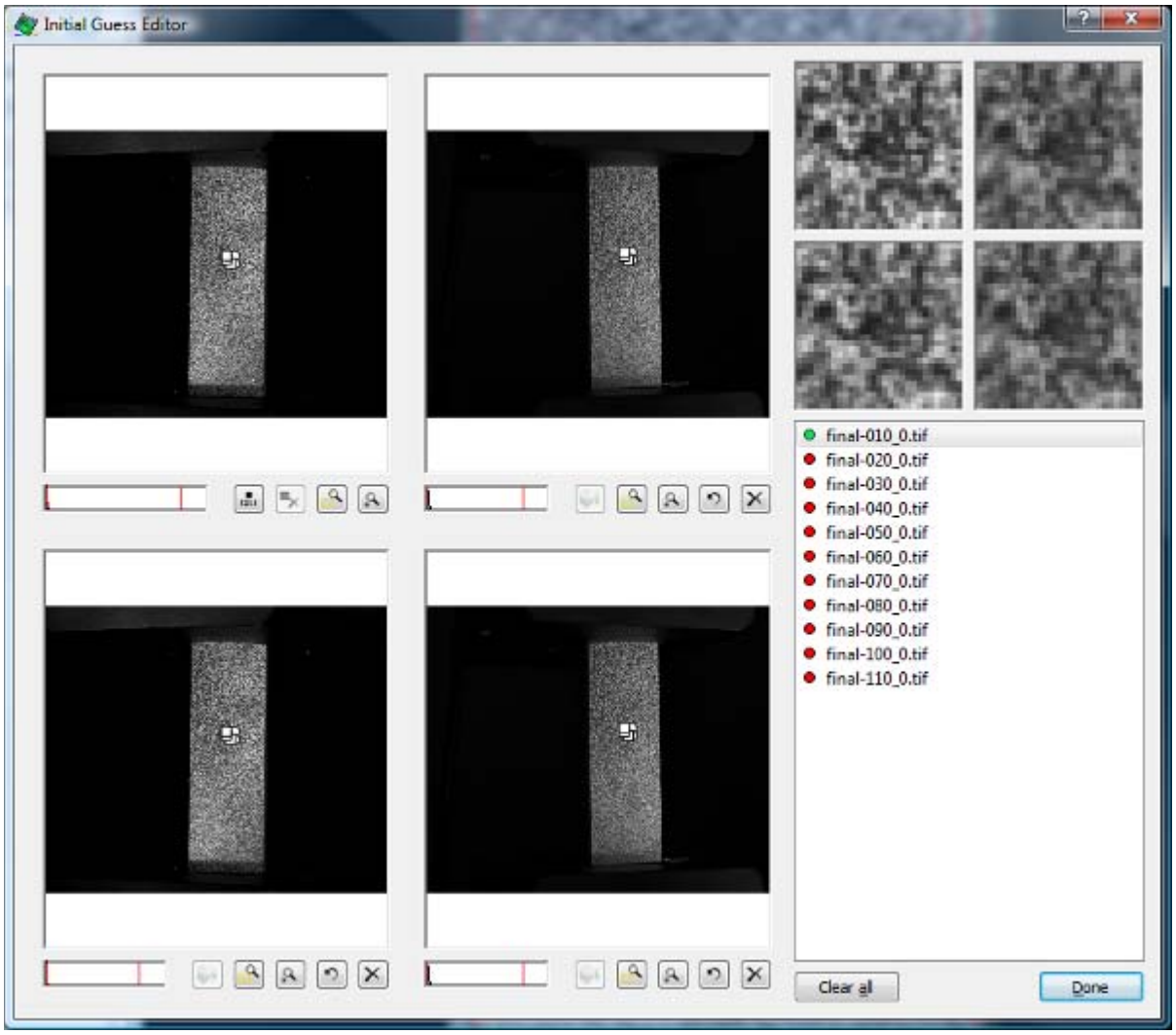
If a specimen is expected to fail or crack, it may help to put start points on either side of the specimen so that once failure occurs there will still be a start point on both surfaces.

For very large transformations or rotations, it can be very helpful to place fiducial marks on the surface. This can be integrated into a printed pattern or simply drawn on the surface with a marker. These marks may be located much more easily than the random pattern especially if, i.e., one image is rotated 180 degrees from the other.

To place the start point, click the icon in the Mask tools box from the AOI Editor. Once a start point is placed, Vic-3D will start looking for initial guesses in the background. If initial guesses are not automatically found, manual editing may be required.

Editing initial guesses

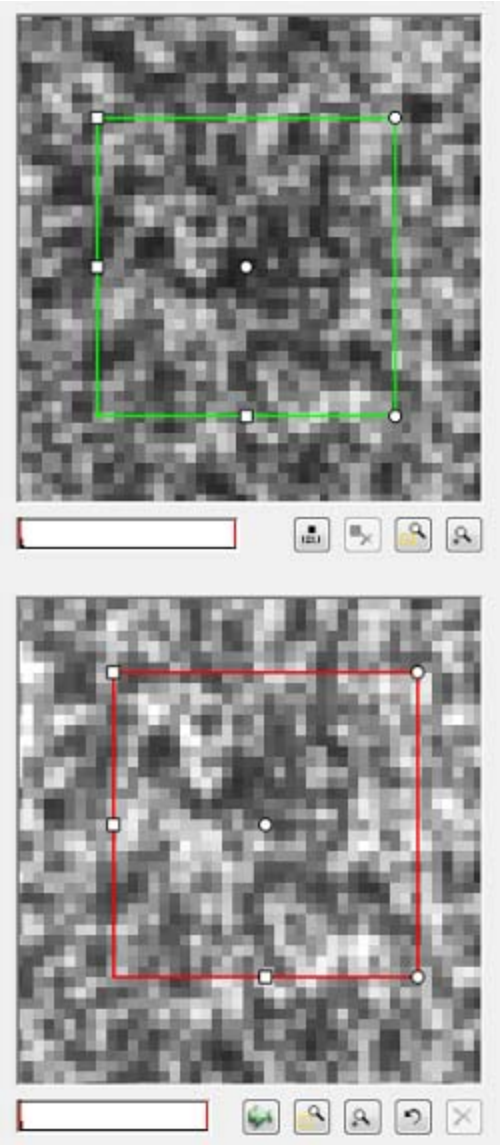
The initial guess dialog can be accessed by double clicking on the icon in the AOI editor, or right-clicking and selecting *Edit guesses*. The Initial Guess Editor will appear.



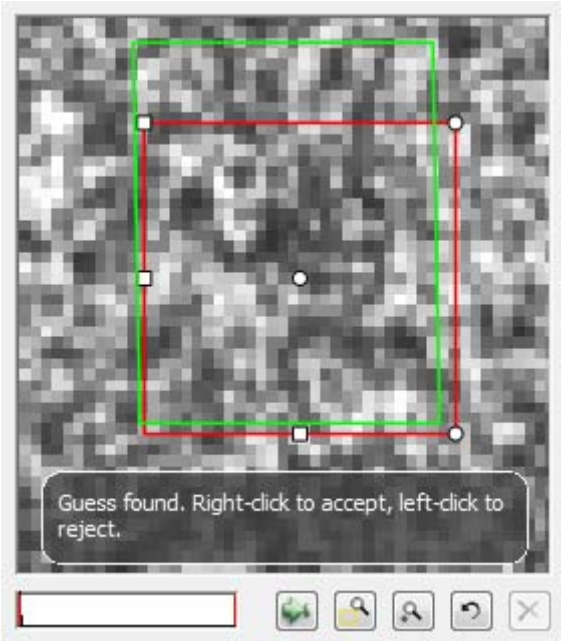
The four windows on the left show the camera 0 and camera 1 reference above, and the camera 0 and camera 1 deformed images below. The small windows at the upper right show the zoomed-in guess for the same four images. The list at the lower left shows all the deformed images; where a guess is already present, the marker will be green. A yellow marker indicates a guess for only one image of that pair, and a red marker means no guess.

To add a guess, drag the corresponding square from the stereo or deformed image until it is in the same spot as the reference camera 0 image (at top left). To make control easier, you can zoom in and out of the image with the mouse wheel, or by clicking the icon and drawing a box; or click the icon to zoom into the current guess area. A histogram control is provided for the reference and deformed images. Adjust the red bars to control image balance; this can be useful for finding detail in very dark images. Double click the histogram to automatically set/reset the limits.

Below, the camera 0 deformed image guess has been dragged to the approximate correct location:



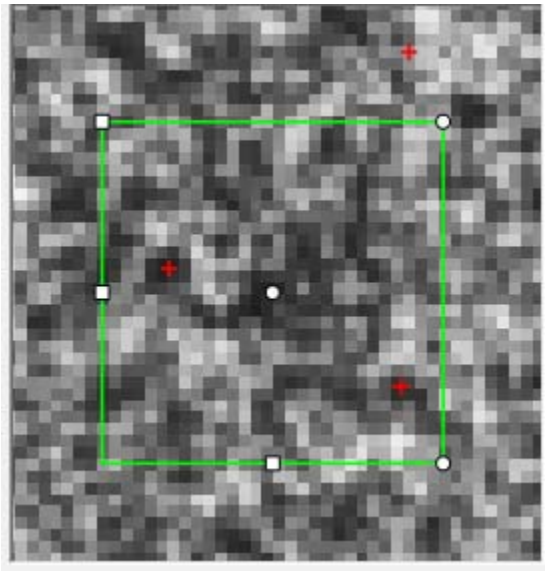
To check the guess, click the icon, or just right-click in the desired image:



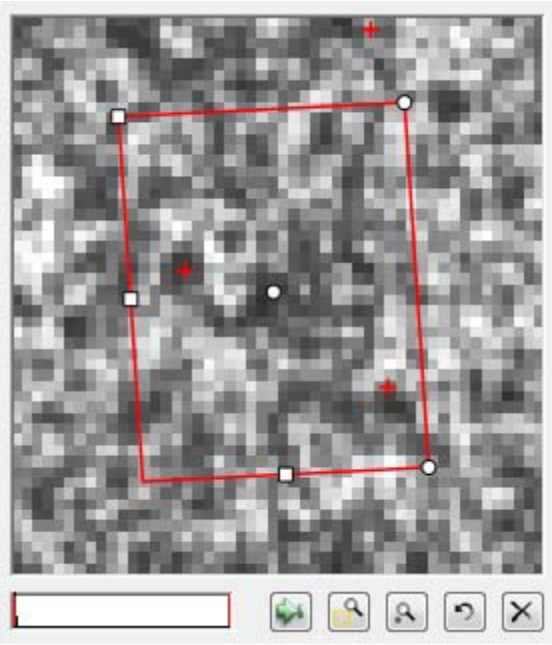
If the correct match is found, you will be prompted to right-click again to accept it. If the match is not found, you can check the location and try again; but where severe scaling or shear is present, you may need to add more details by adding more points or setting scaling/shear.

Detailed initial guesses

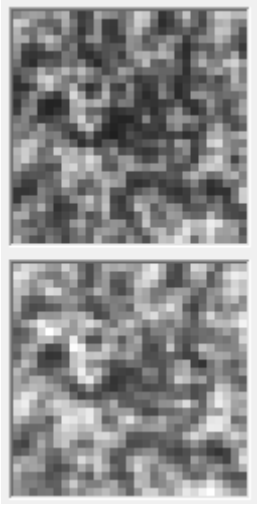
To add deformation to your guess, you can add control points to the reference image by clicking the icon. Up to three points can be added:



To specify the deformation, you can drag the corresponding points in the deformed image to matching points. Note that Vic-3D will not allow points that are too close together, or too close to colinear. Delete points by clicking then clicking the point to remove.



While you are dragging, you will see that the small view to the upper right changes to reflect the transformed subset. When the match is good, the two views will look very similar:



You may also drag the control points on the red rectangle to adjust the transform more directly. The upper left control point affects rotation; the left and bottom points control X and Y scaling; and the upper right and lower right points control shearing.

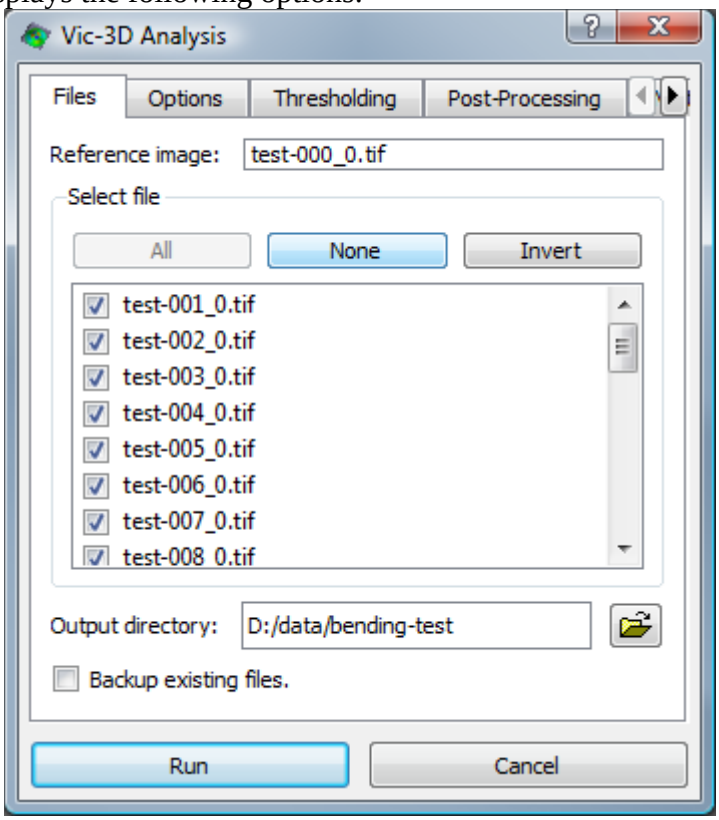
In most cases where a manual initial guess is required, you will only have to provide a stereo guess (for the initial reference pair); the deformation guesses will be automatically determined during the correlation process. To help this work as smoothly as possible, take many images, and keep image-to-image displacements small; also, place start points in lower-motion areas as described above.

Running the Correlation

To run the displacement analysis, select the *Run Correlation* entry from the *Data* menu, or press the button on the tool bar.

The File Tab

The tab on the dialog displays the following options:



Selecting Images

The deformed images to use for correlation analysis can be selected from the list box on the dialog. Selected images are indicated by a check mark. Above the list box, buttons are available to select/deselect all image files contained in the list box. To select 1 data file from from every 2, 5, 10, or *n* , right-click in the file list and choose the desired option.

If no images are selected, only the reference image is analyzed.

Backup copies

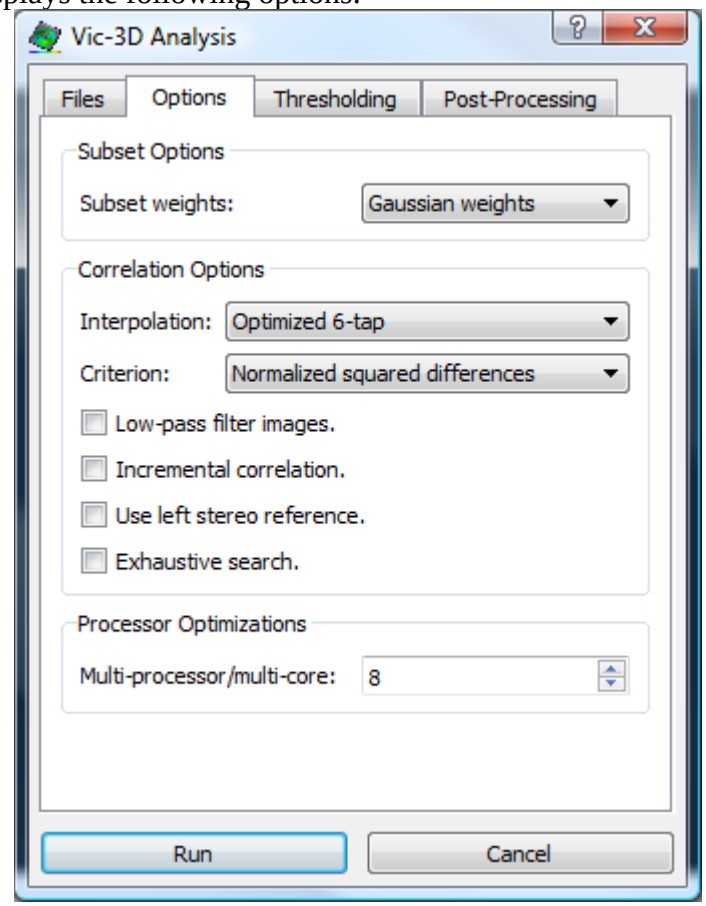
When this option is checked, Vic-3D will make backup copies of existing output files by replacing their file extension with *bak*.

Output directory

The directory in which the output files are stored can be selected by clicking the folder icon.

The Options Tab

The tab on the dialog displays the following options:



Subset weights

This option controls the way pixels within the subset are weighted. With Uniform weights, each pixel within the subset is considered equally. Selecting Gaussian weights causes the subset matching to be center-weighted. Gaussian weights provide the best combination of spatial resolution and displacement resolution.

Interpolation

To achieve sub-pixel accuracy, the correlation algorithms use gray value interpolation, representing a field of discrete gray levels as a continuous spline. Either 4-, 6-, or 8-tap splines may be selected here.

Generally, more accurate displacement information can be obtained with higher-order splines. Lower-order splines offer faster correlation at the expense of some accuracy.

Criterion

There are three correlation-criteria to choose from:

- Squared differences: Affected by any lighting changes; not generally recommended.

- Normalized squared differences: Unaffected by scale in lighting (i.e., deformed subset is 50% brighter than reference.) This is the default and usually offers the best combination of flexibility and results.
- Zero-normalized squared differences: Unaffected by both offset and scale in lighting (i.e., deformed subset is 10% brighter plus 10 gray levels.) This may be necessary in special situations. However, it may also fail to converge (produce a result) in more cases than the NSSD option.

Low-pass filter images

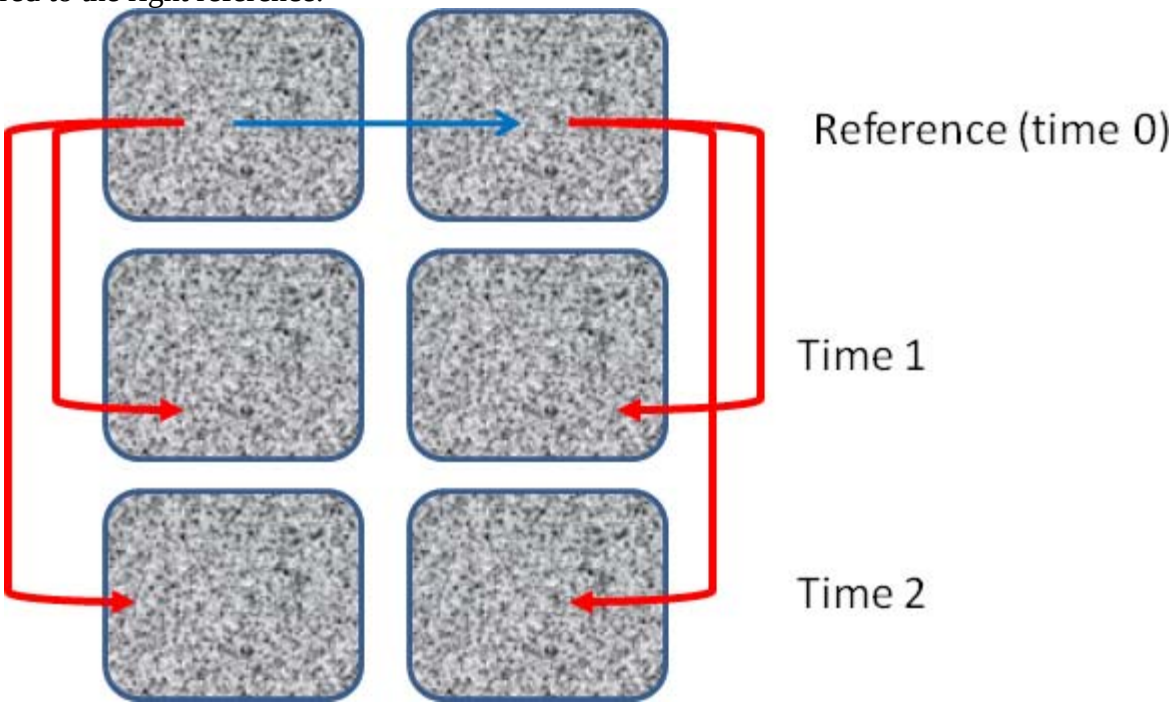
The low-pass filter removes some high-frequency information from the input images. This can reduce aliasing effects in images where the speckle pattern is overly fine and cannot be well represented in the image. (These aliasing effects are often visible as a moire-type pattern in the output data.)

Incremental correlation

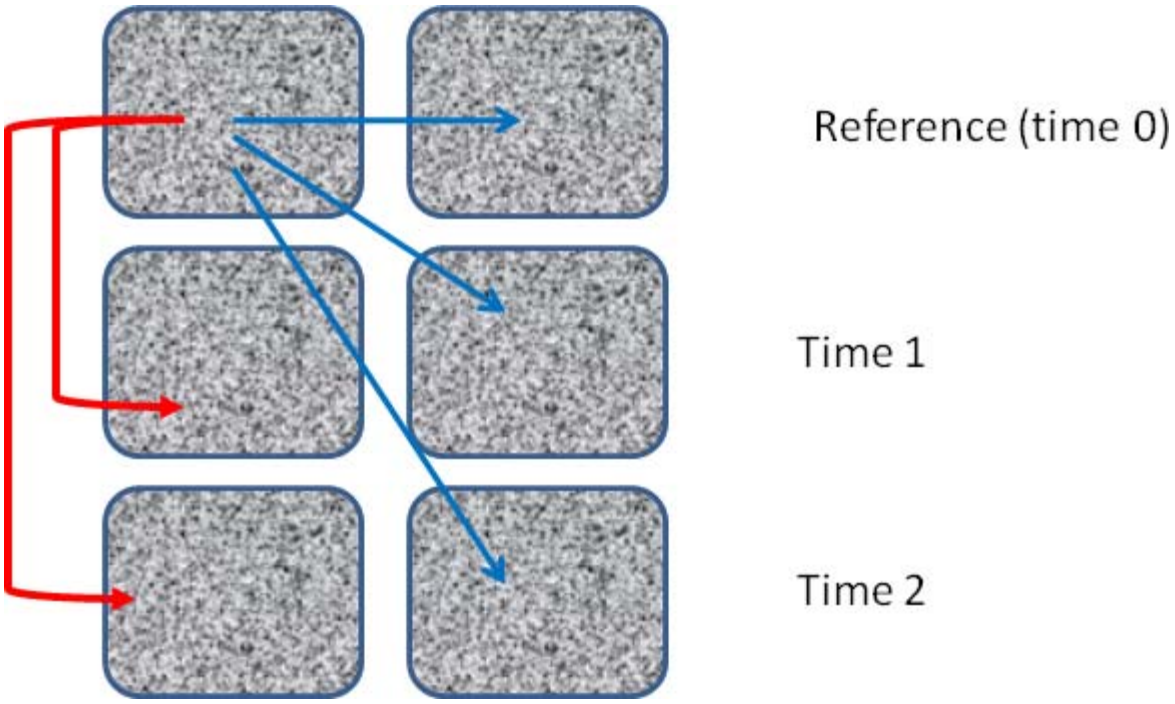
With incremental correlation, each image is compared to the previous image rather than the reference image. This can be useful in cases of pattern breakdown or extremely high strains (>100%). This comes at the expense of an increase in noise for later images, because the noise continues to add over each successive correlation.

Use left stereo reference

By default, Vic-3D 2010 compares the left to the right image only once: in the initial stereo pair. After this point, succeeding left images are compared to the left reference, and succeeding right images are compared to the right reference:



In prior versions, both left and right images from any point in the sequence were always compared to the left reference image:



To force this latter behavior in Vic-3D 2010, check the "left stereo reference" box.

Exhaustive search

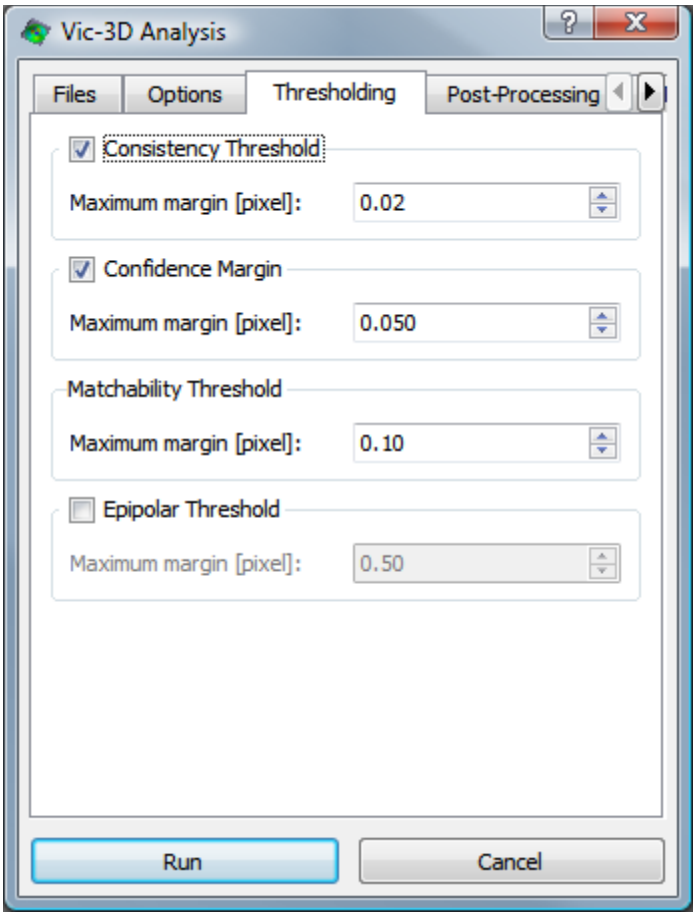
Enabling this option will cause Vic-3D to repeat a coarse search for matches after each time the correlation fails. This may result in more data recovery at the expense of vastly increased processing time.

Processor Optimizations

This option controls the number of processors/cores Vic-3D uses for analysis. In most cases this will be correctly determined automatically by Vic-3D.

The Thresholding Tab

This tab provides options for removing any data that is bad or suspect while maximizing the amount of retained data. Four thresholding options are available. For a typical test, the default values will work very well, but when conditions are unusual or substandard (blur; debris; poor lighting; etc), some adjustment may be required.



Consistency threshold

After Vic-3D analyzes the seed point, the analysis is propagated to each of its four neighbors, and so on. Each point is fed with a prediction of its approximate match. After the match is made, a *back*-prediction is calculated. If the back-prediction does not closely match the actual location of the prior neighbor, this threshold will remove the data.

Confidence margin

For each match, Vic-3D calculates a statistical confidence region, in pixels, using the covariance matrix of the correlation equation. If the confidence region exceeds this threshold, the data will be removed.

Matchability threshold

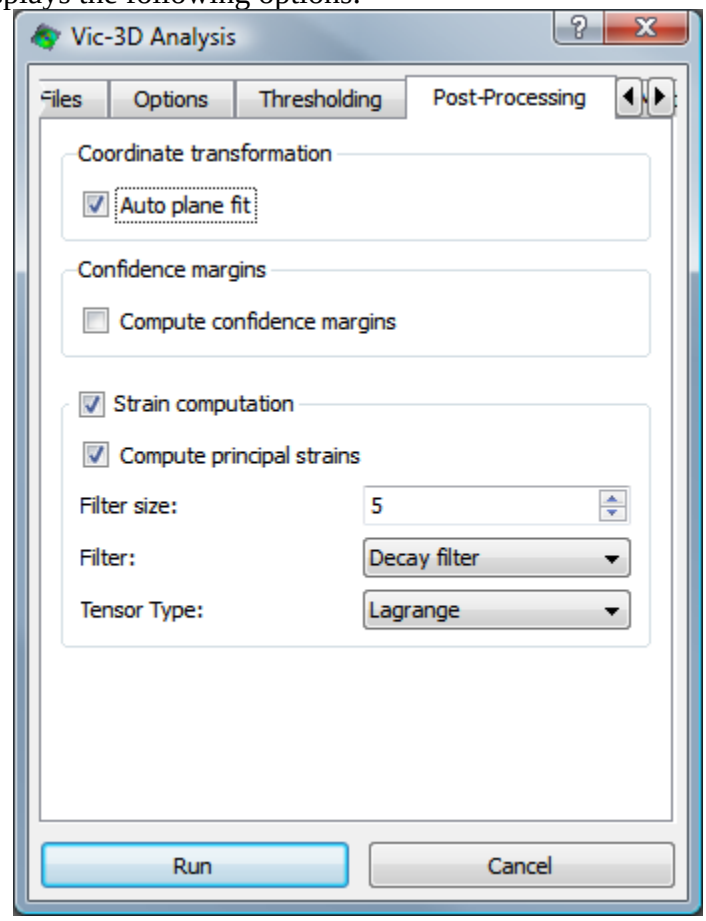
This option automatically removes subsets that show a very low contrast, i.e, subsets that don't contain very much information. Increase this value to remove more data; reduce to retain more data, i.e., if lighting conditions were poor.

Epipolar threshold

If a calculated match does not lie very close to the epipolar line, this threshold removes the data. High projection error may be caused by motion blur; a poor calibration; or cameras which are not rigidly mounted.

The Post-Processing Tab

The tab on the dialog displays the following options:



Auto plane fit

Checking this option will create a coordinate system based on the reference shape. The origin will be at the mass centroid of all measured points, with the Z-axis normal to the best-fit plane of the data field.

Leaving this option cleared wil return results in camera coordinates. If custom coordinate transforms are to be used, you should always start with camera coordinates to establish a consistent Cartesian reference frame rather than one that may move based on the data.

Compute confidence margins

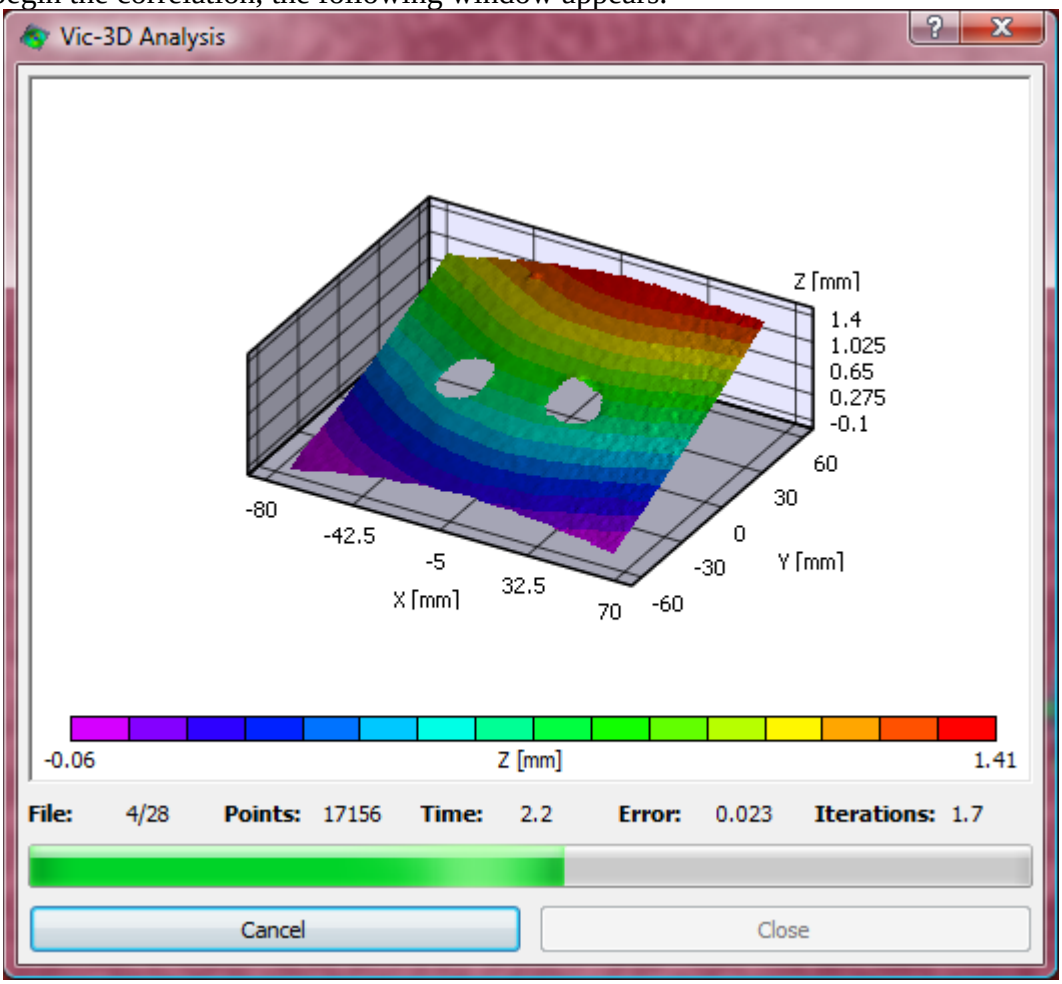
Check this box to add metric confidence margins for X, Y, and Z position and displacement. The new variables represent the 1-standard-deviation confidence for the position, computed from the pixel confidence margin together with the camera geometry.

Strain Computation

Checking this option performs a strain computation as each image is processed; results can be viewed in the preview.

Correlation Results

After you begin the correlation, the following window appears.



The window contains an overview of correlation progress and reults.

File - the progress and total number of files to analyze.

Points - the number of data points calculated for the image.

Time - The amount of time spent on correlation analysis in seconds.

Error - a measure of correlation accuracy (specificially, epipolar projection error). A high number indicates possible problems with calibration or camera synchronization.

Iterations - a measure of how many possible matches were searched for each point.

Progress bar- indicates the progress of each individual file as it is correlated.

This window also contains a preview of the output data. This data may be view in 2D and 3D and manipulated as with a standard plot.

When the analysis is complete, you may click View Report to see a summary of the above data.

For more information on interpreting correlation results and troubleshooting errors, please contact Technical Support.

Coordinate tools

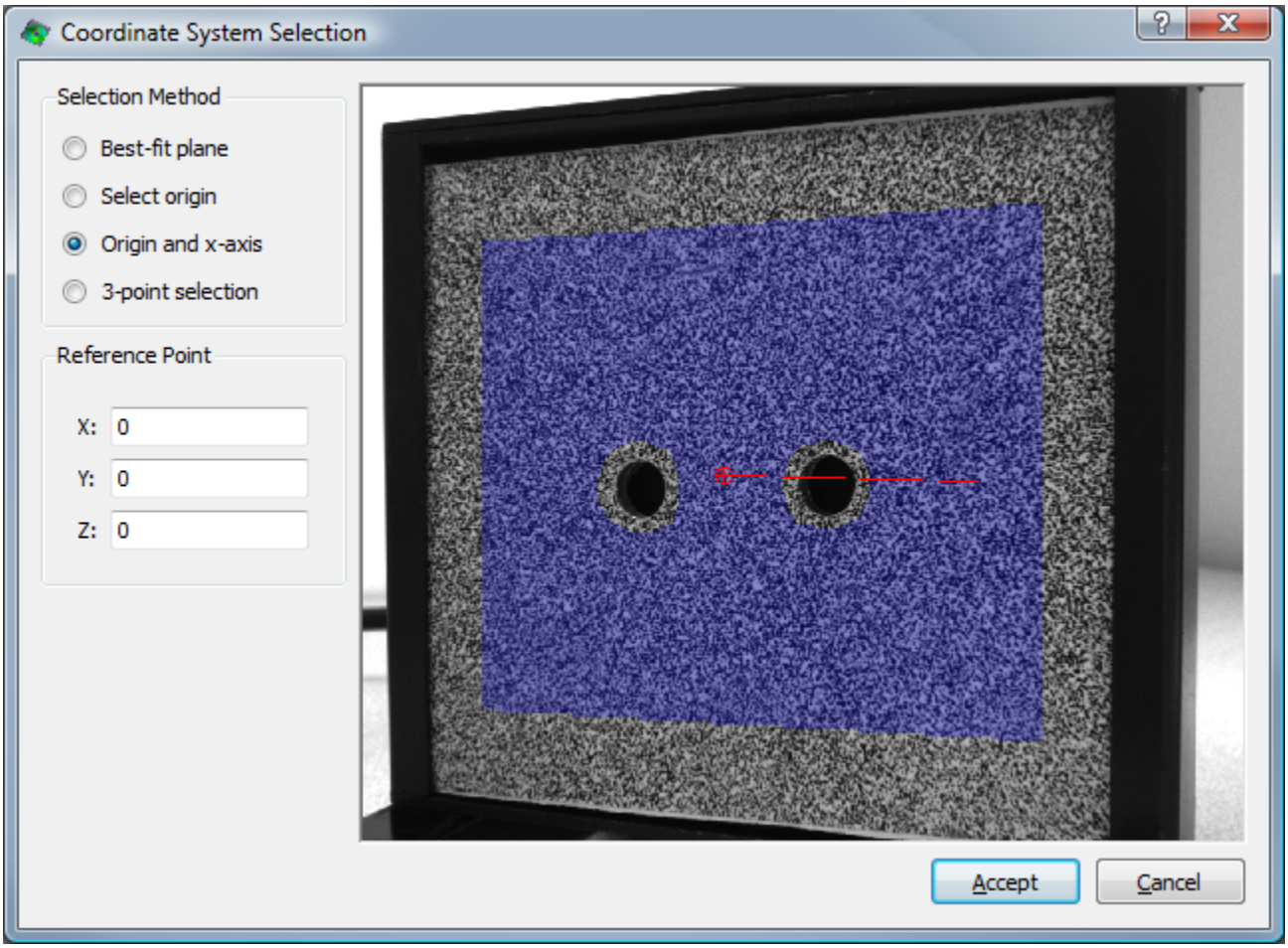
The calculated cloud of XYZ positions and UVW displacements can be modified into a different Cartesian coordinate system, or a polar coordinate system, using these options.

- **Apply transformation** - applies a previously saved transformation to selected data files
- **Best plane fit** - fits the data to the approximate plane of a selected data file
- **Select coordinate system** - select an origin, X-axis direction, or XY plane
- **Import from project file** - bring in a transform saved in a different Z3D or V3D project file
- **Input manually** - enter a transform in terms of angles, or specify a transformation matrix
- **Rigid transform from displacements** - calculate a transform from the displacement between two images
- **Compute cylinder transformation** - select a polar coordinate system, for nearly cylindrical surfaces
- **Apply cylinder transformation** - apply a saved polar coordinate transform

Coordinate System Selection

Coordinate system transformations can be selected based on the 3D data contained in the reference data file. To efficiently use coordinate transformations, make sure to disable automatic transformation during data analysis; see Coordinate Transformation for details. To select a coordinate system, select *Data... Coordinate Transformation... Select coordinate system* from the main menu bar.

The following dialog will be displayed:



Selection Method

There four choices to select a coordinate system:

Best Plane Fit

Select this option to calculate a transform into the best fit plane of the surface. This is the same as selecting Best Plane Fit from the coordinate transform menu.

Select Origin

Use this option to designate an origin for the coordinate system, while leaving the orientation unchanged. Simply click Select Origin, and pick a point in the image. This point becomes 0,0,0 in the

x,y,z coordinate system. The orientation of the axes will be determined from the best plane fit.

This transform is useful when a specific point in the image is a convenient reference origin, for example, a notch in the specimen.

Origin and x-axis

Selecting this option allows the designation of the coordinate origin as well as the x-axis. After selecting, click a point in the image to become the coordinate origin. Click a second point to indicate the direction of the positive x-axis. The direction of the y-axis will be determined from the best plane fit.

This transform is useful when both a specific origin point and an orientation are desired; for instance, the origin could be a crack tip and the axis could be the direction of the crack opening.

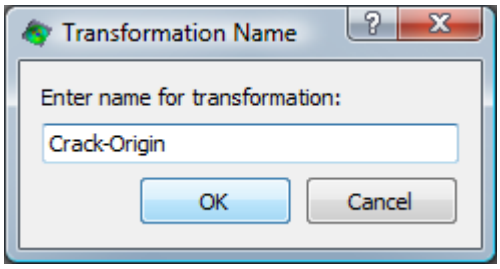
3 point selection

This option allows selection of an origin and the complete orientation of the axes. Select a point to become the origin. Select a second point to indicate the direction of the x-axis. Finally, select a third point to indicate a third point on the xy-plane; this will completely define an origin and xyz orientation.

Reference Point

If desired, enter a coordinate to be designated by the reference point; this will change the point designated by the first click from (0,0,0) to the specified coordinates.

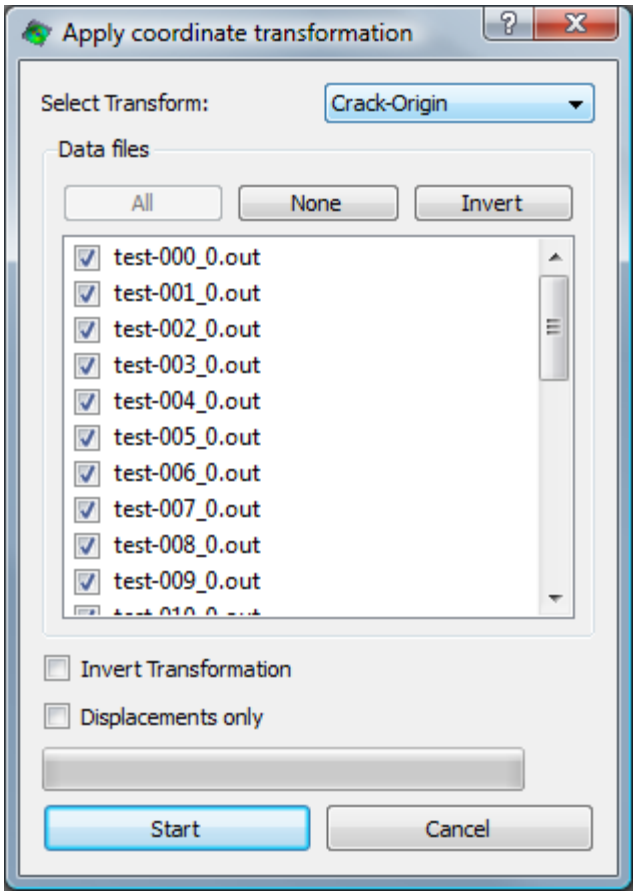
Click Accept to calculate the new coordinate transform. The following dialog appears:



Enter a name to add the transform to the current project. At this point you will be prompted to apply this transform to all current data files; click Yes to apply or No to leave the data as is.

Applying Transformations

Coordinate system transformations can be applied to data files by selecting the *Apply Transformation* entry from the *Coordinate System Transformation* menu. The following dialog lets you choose which transformation to apply, and which data files to apply the transformation to.



To invert (undo) the selected transformation, check *Invert Transformation*.

Each transform contains 3 rotation components and 3 translation components. By default, only the rotation is applied to the U, V, and W displacement variables; that is, the displacement vectors are rotated with the surface, but their magnitude is unchanged. To apply the translation components as as well, altering the displacement vectors' magnitude, click *Displacements only*.

Note: if strains are present in the input data, a warning will appear indicating that they will not be transformed. It will be necessary to recalculate strain for the x and y components to be correctly aligned with the new coordinate system.

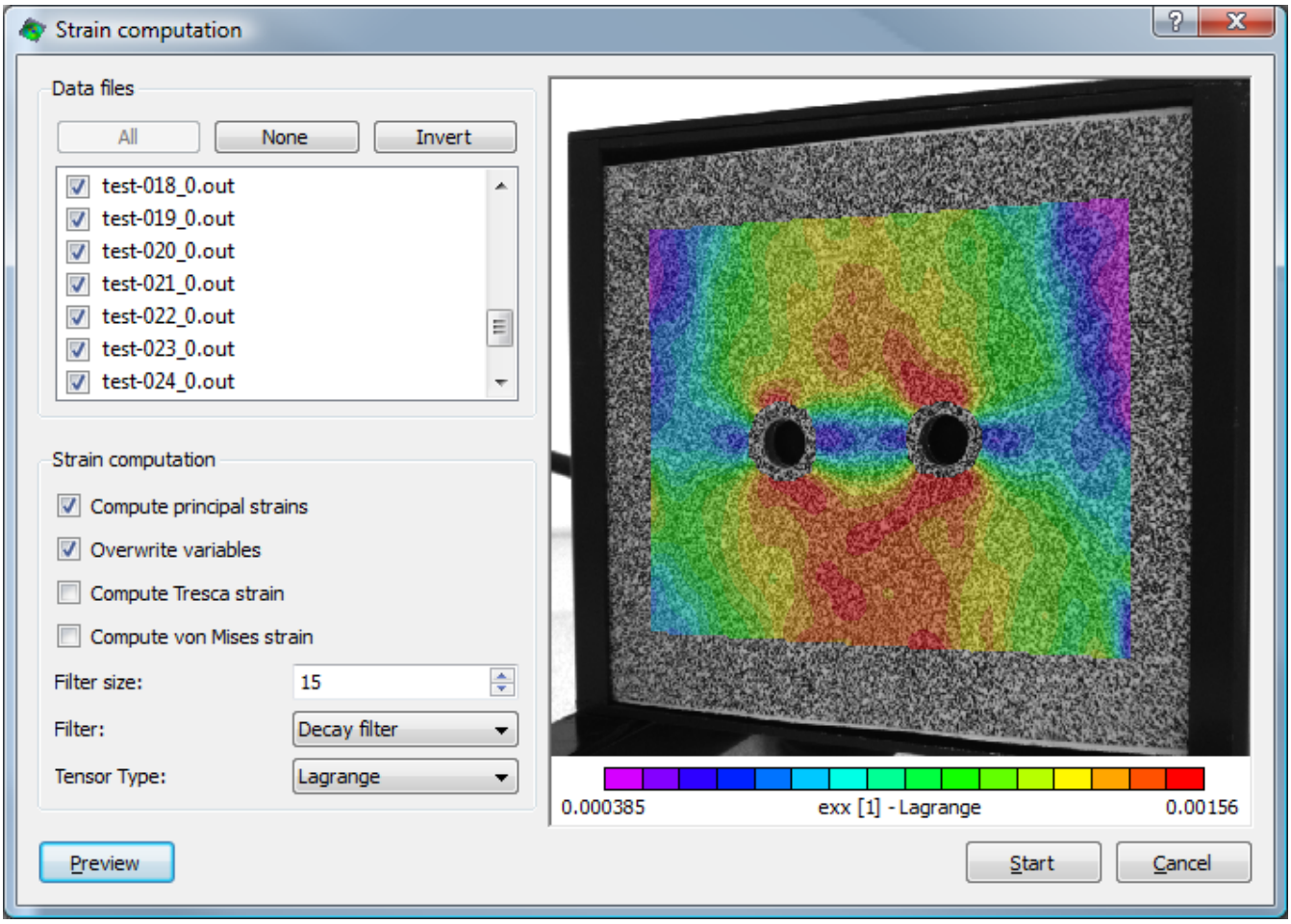
Postprocessing tools

Once the initial position and displacement fields are calculated, several tools are available for processing the data.

- **Calculate strain** - calculate surface strain tensors
- **Remove rigid motion** - removes overall object motion, leaving only deformation
- **Apply function** - apply arbitrary user-defined functions to create new variables
- **Restore data** - uses initial triangulation data to recreate original position and displacement field
- **Calculate velocity** - uses time information to calculate velocity and strain rate
- **Calculate curvature** - calculates local curvature over the surface
- **Calculate in-plane rotation** - calculates local surface rotation
- **Smooth** - smooths data over a user-specified diameter
- **Map external data** - map data from an external source such as an IR camera
- **Delete variables** - remove variables created with other postprocessing tools
- **Combine data files** - combine multiple data files for display as one
- **Apply math operation** - applies simple math operations to discrete variables

Strain Calculation

To calculate strain for a set of data, select *Data... Postprocessing options... Calculate strain* from the main menu.



Selecting Data Files for Processing

The available data files are displayed in the *Data Files* list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

Preview

To view the effects of the calculation for a single data file, highlight the file and click the *Preview* button. You may view the plot in 2D or 3D as with a standard data plot.

Compute principal strains

Check this box to add principal strains and principal strain angle to the calculated output data.

Overwrite variables

Check this option to overwrite any existing strain calculations. If this box is clear, more data fields will be added to the output data set each time strain is calculated.

Compute Tresca/von Mises strain

Select these options to compute the Tresca/von Mises strain criterion along with the strain tensor calculation.

Filter size/type

Calculated strains are always smoothed using a local filter. The *Filter* box allows selection of a smoothing method. The decay filter is a 90% center-weighted Gaussian filter and works best for most situations; the box filter is a simple unweighted averaging filter.

The *Filter size* box controls the size of the smoothing window. Since the filter size is given in terms of data points rather than pixels, the physical size of the window on the object also depends on the step size used during correlation analysis.

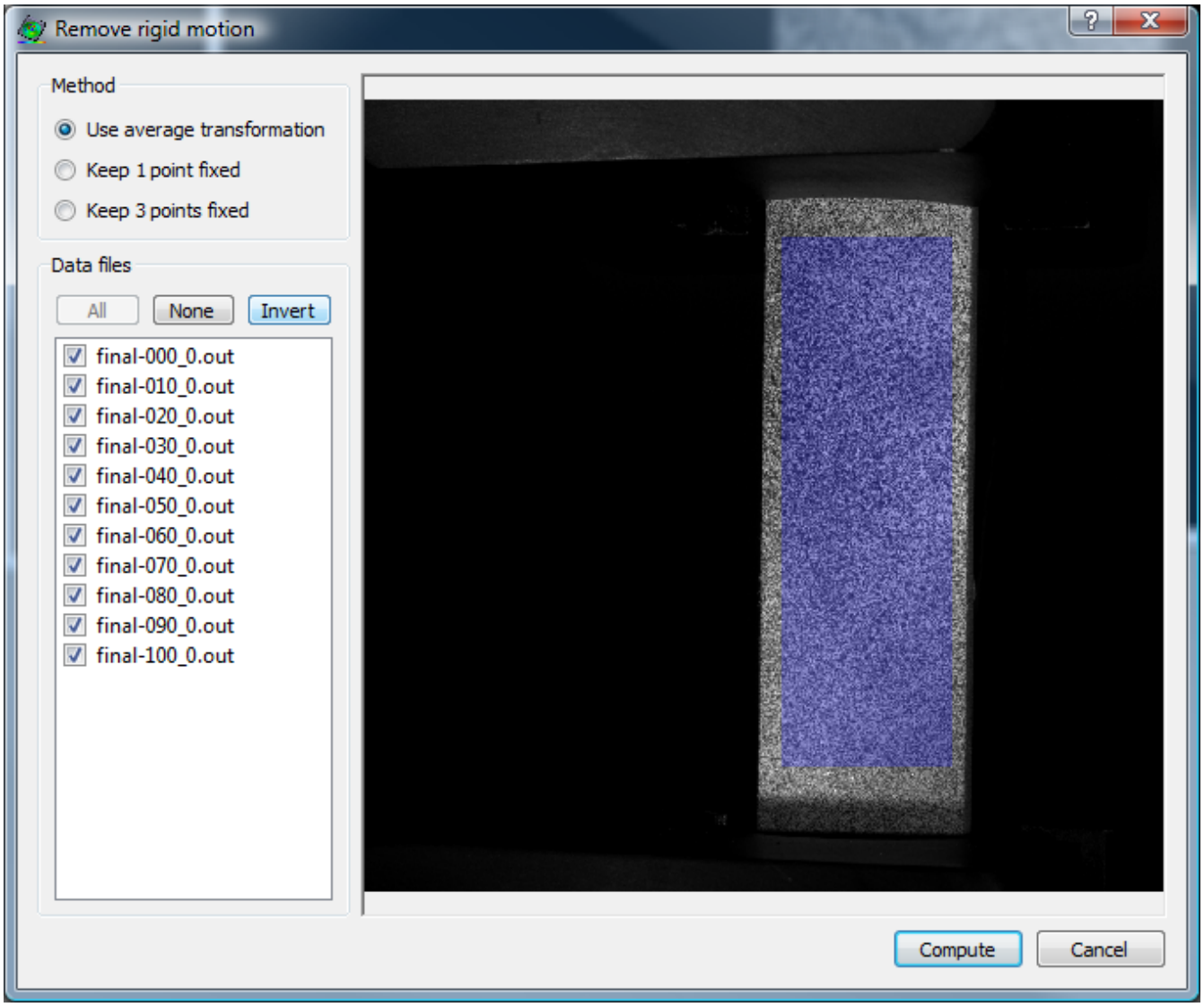
Tensor type

Select the desired strain tensor. The default is Lagrangian finite strain.

Removing Rigid Motion

This tool is used to remove rigid-body displacement from deformed images, leaving only deformation components of displacement.

Once the displacement fields have been calculated from the speckle images, this tool can be started by selecting *Data... Remove displacements*.



Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

Processing method

To remove all rigid body displacement, select *Use average transformation*. This will calculate the average

transformation for each image, and invert it to obtain an image with an average displacement/rotation of 0. Only object *deformation* will be reflected in the transformed U, V, and W displacements. This is useful for visualizing displacement fields in tests where deformation is obscured by larger, rigid-body motions.

To keep a single point stationary, select *Keep 1 point fixed* and click the desired point in the image. Only points within the data set (highlighted in blue) may be selected. With this method, the selected point will become stationary, with all other displacements remaining relative to this point. Any initial rotation will still be present after the operation.

To keep three points stationary, select *Keep 3 points fixed*; then, click three desired points in the image to define the fixed points. With this method, all displacements and rotations will be relative to the three selected points, which will become stationary. The point- and three-point displacement options are useful for, i.e., determining deformation of a test subject relative to fixed mounting points or standoffs.

If the three points you select are in three different AOI's, you will be given the option to use the entire AOI for the operation. This will be useful if, for example, you have small AOIs on top of three separate fixed posts of a test fixture.

Click *Compute* to proceed with the computation.

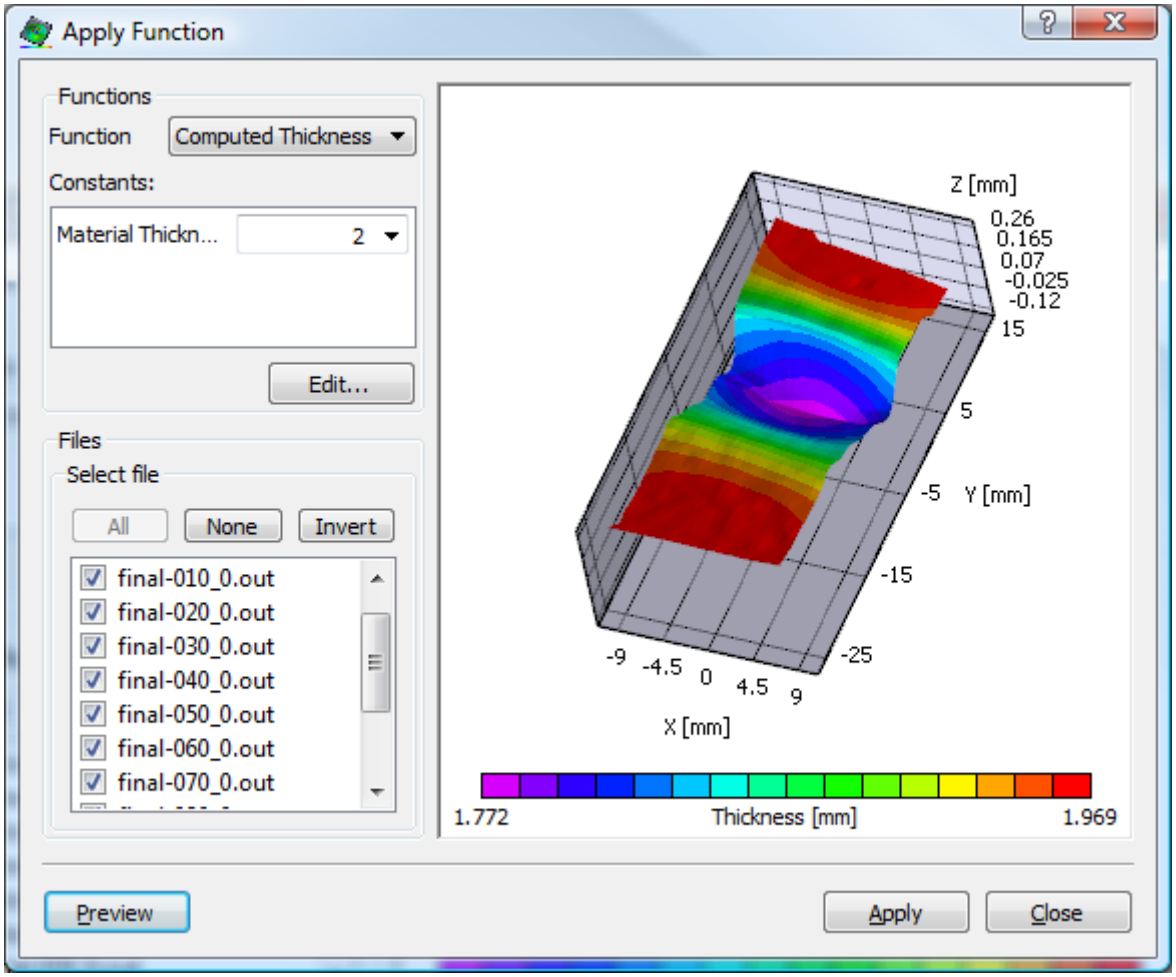
Strain calculation

Note that these transforms will not affect calculated strain, nor are they necessary in order to correctly calculate strain; the strain algorithm is, by nature, insensitive to rigid-body displacements.

Applying Functions to Data

Vic-3D supports the generation of new variables based on equations applied to the data. This feature can be used, for instance, to compute engineering strains from Lagrange strains, to compute stresses from strains or to compute thinning of a strained specimen of known thickness based on the Poisson's effect or volume conservation during plastic deformation.

To apply function to a data sequence, select *Data... Postprocessing options... Apply function* from the main menu.



Function

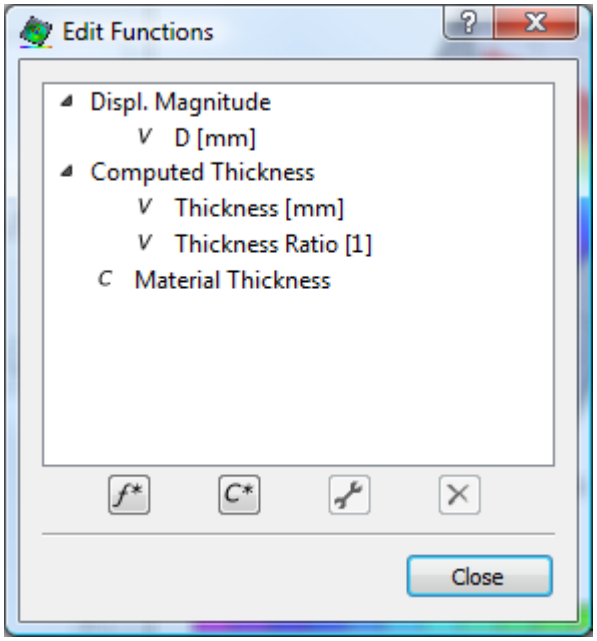
Select a function which you wish to apply to the data.

Constants

Each function may have constants that are used in its equations. The constants are displayed next to their current values. Some constants may contain pre-defined options for the value. Selecting any of the options in the value combo-box will set the constant to that value.

Creating and editing functions and constants

New functions and constants can be created and existing ones can be edited. Click on the **Edit...** button to open up the *Edit Functions* dialog.



All available functions and constants are listed. Constants local to a function and the outputs of a function are listed underneath the function they belong to.

The four buttons underneath the list allow for the creation, editing and deletion of functions or constants. Each of the buttons are as follows:

Opens the wizard to create a new function.

Opens the wizard to create a new constant.

Opens a wizard to edit the selected function or constant. If an output is selected it opens the function wizard to the edit outputs page.

Deletes the selected function or constant. If an output is selected it delete the function it belongs to.

Double-clicking on any item in the list will open the respective wizard for editing.

Selecting Data Files for Processing

The available data files are displayed in the list box on the bottom left of the dialog. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

Preview

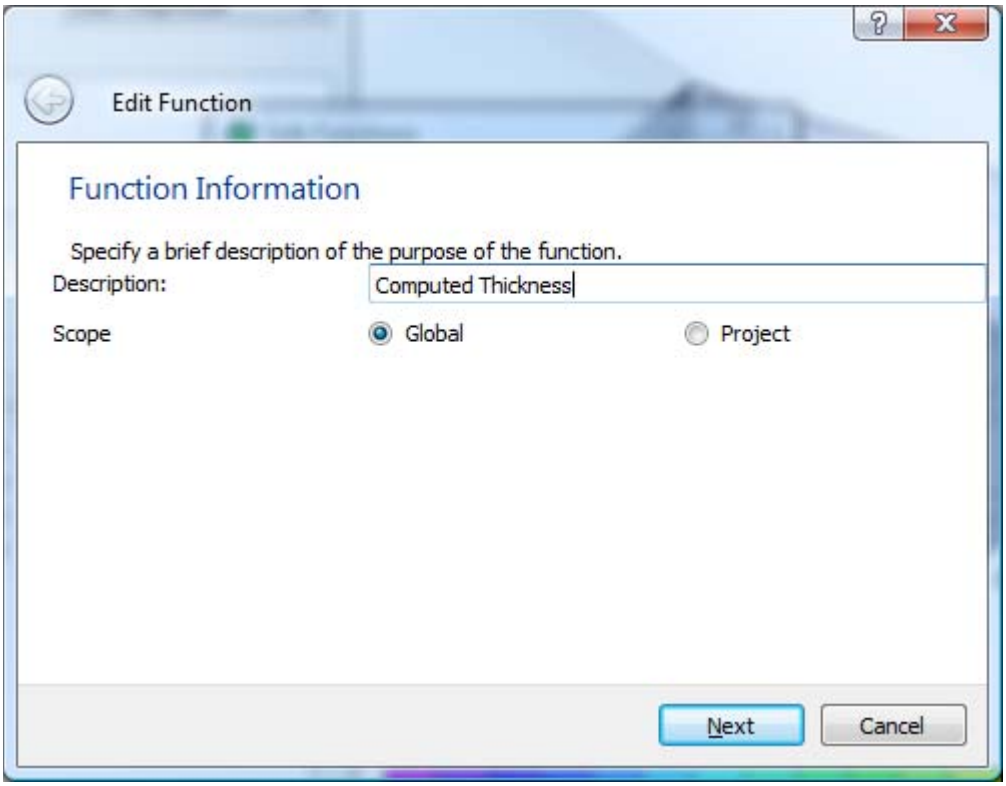
To view the effects of the calculation for a single data file, highlight the file and click the *Preview*

button. You may view the plot in 2D or 3D as with a standard data plot.

Creating and Editing Functions

Function Information

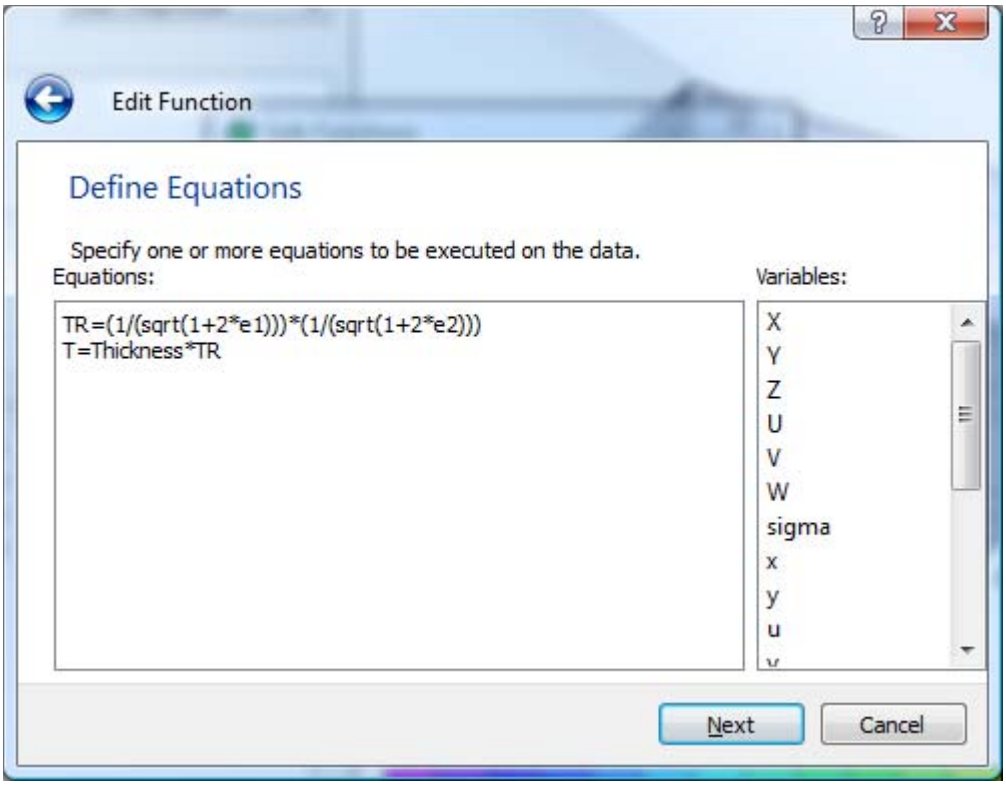
The first page of the function wizard is for entering a brief description of the function and the scope in which the function is stored. The *Global* scope option stores the function in the program settings where it can be used by any project. The *Project* stores the function in the project itself. If the project option is selected, then the function and it's local constants are stored in the current project and is only accessible by the current project.



Define Equations

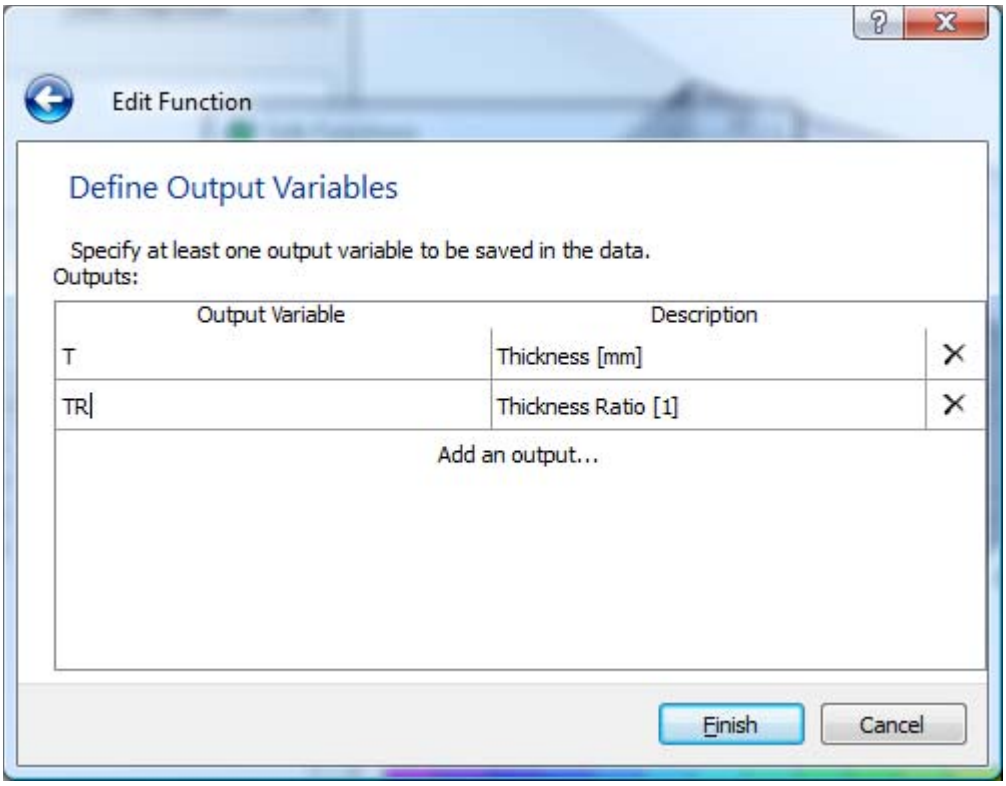
The next page is where the actual equations are entered. There can be multiple equations and they are separated by a new line; each should be in the form (variable)=(function definition). Double click on a variable at left to insert it at the cursor.

After you enter your equations and click *Finish*, any errors will be announced and corrections will be required before proceeding.



Define Output Variables

Every function must have at least one output variable. The output variable is the information that is stored in the data files of the project. To add one, simply click *Add an output...* There are two things to be entered for each output. The first is the actual variable itself as used in equations. The second is a brief description of the variable - this will be displayed in plot context menus. The 'X' icon is the delete button. Clicking it will delete the associated output.


Edit Function
Define Output Variables
Specify at least one output variable to be saved in the data.
Outputs:
Output Variable
Description
T
Thickness [mm]
TR
Thickness Ratio [1]
Add an output...
Finish
Cancel

Format for Equations in Vic-3D

The following table lists the functions that can be used in equations in Vic-3D and the number of arguments they require.

Function name	Argument count	Explanation
sin	1	sine function
cos	1	cosine function
tan	1	tangens function
asin	1	arcus sine function
acos	1	arcus cosine function
atan	1	arcus tangens function
sinh	1	hyperbolic sine function
cosh	1	hyperbolic cosine
tanh	1	hyperbolic tangens function
asinh	1	hyperbolic arcus sine function
acosh	1	hyperbolic arcus cosine function
atanh	1	hyperbolic arcus tangens function
log2	1	logarithm to the base 2
log10	1	logarithm to the base 10
log	1	logarithm to the base 10
ln	1	natural logarithm to base e (2.71828...)
exp	1	e raised to the power of x
sqrt	1	square root of a value
sign	1	sign function -1 if x<0; 1 if x>0
rint	1	round to nearest integer
abs	1	absolute value
min	var.	min of all arguments
max	var.	max of all arguments
sum	var.	sum of all arguments
avg	var.	mean value of all arguments

The table below lists the binary operators available in Vic-3D in order of priority (higher values mean higher priority).

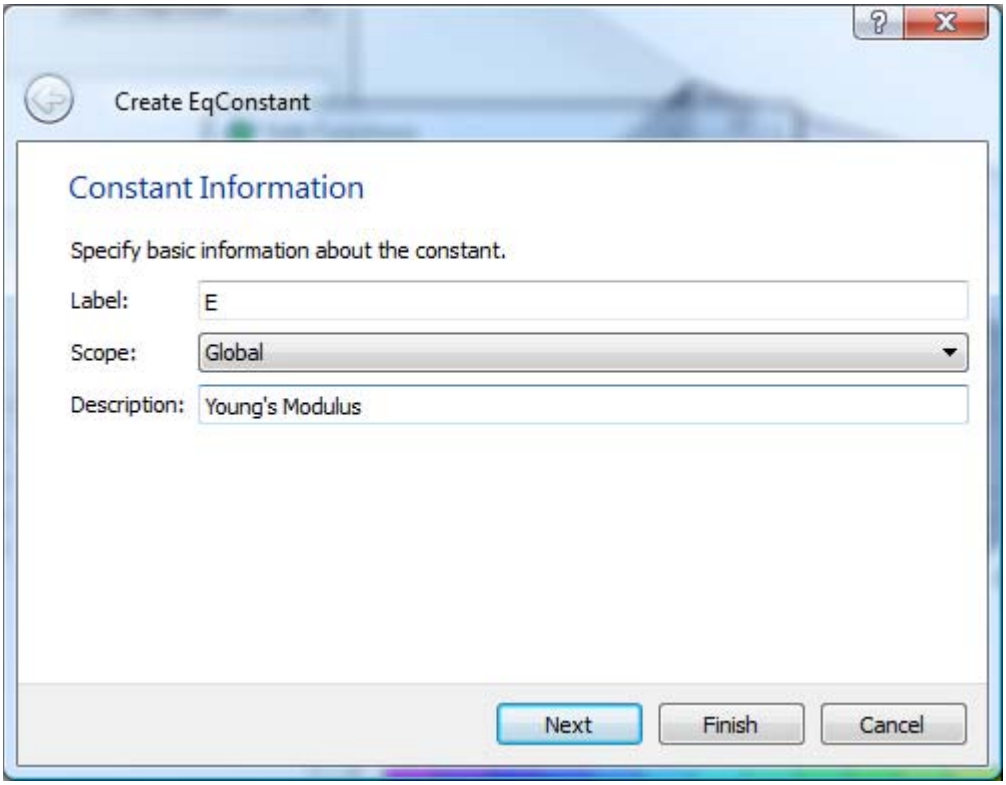
Operator	Meaning	Priority
and	logical and	1
or	logical or	1
xor	logical xor	1

<=	less or equal	2
>=	greater or equal	2
!=	not equal	2
==	equal	2
>	greater than	2
<	less than	2
+	addition	3
-	subtraction	3
*	multiplication	4
/	division	4
^	raise x to the power of y	5

Creating and Editing Constants

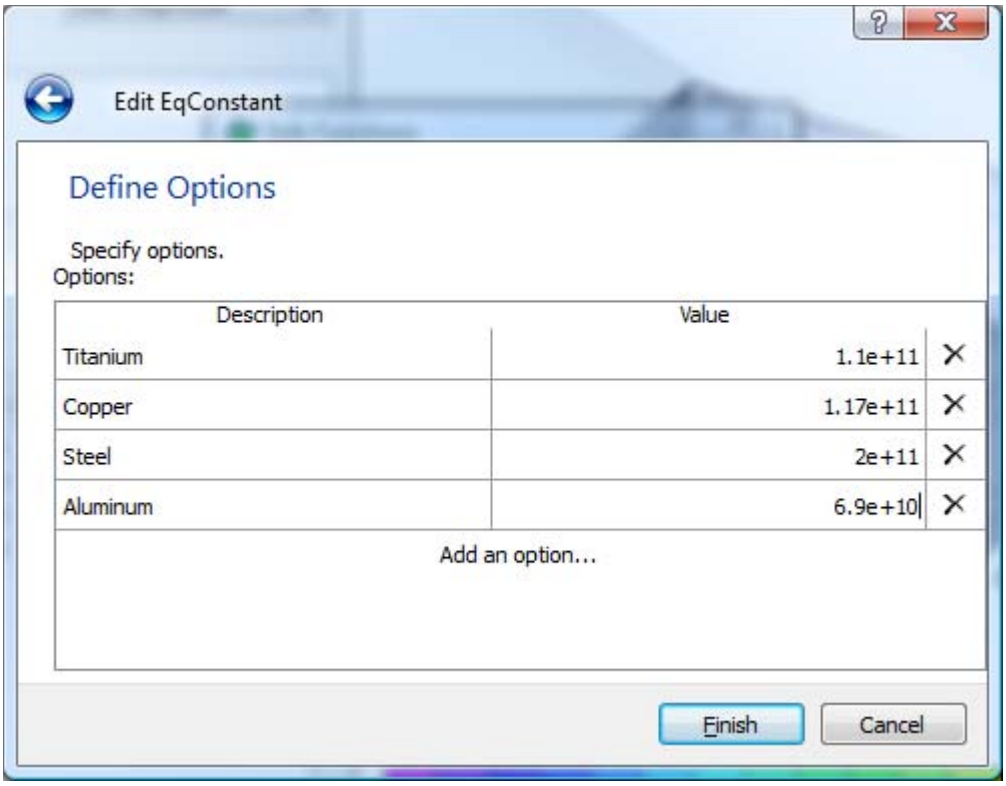
Constant Information

The label defines what is to identify a given constant in an equation. The scope defines whether or not the constant is accessible to all functions (*Global*) or if it is only accessible to a specific function. The description is used to note the purpose of the constant.



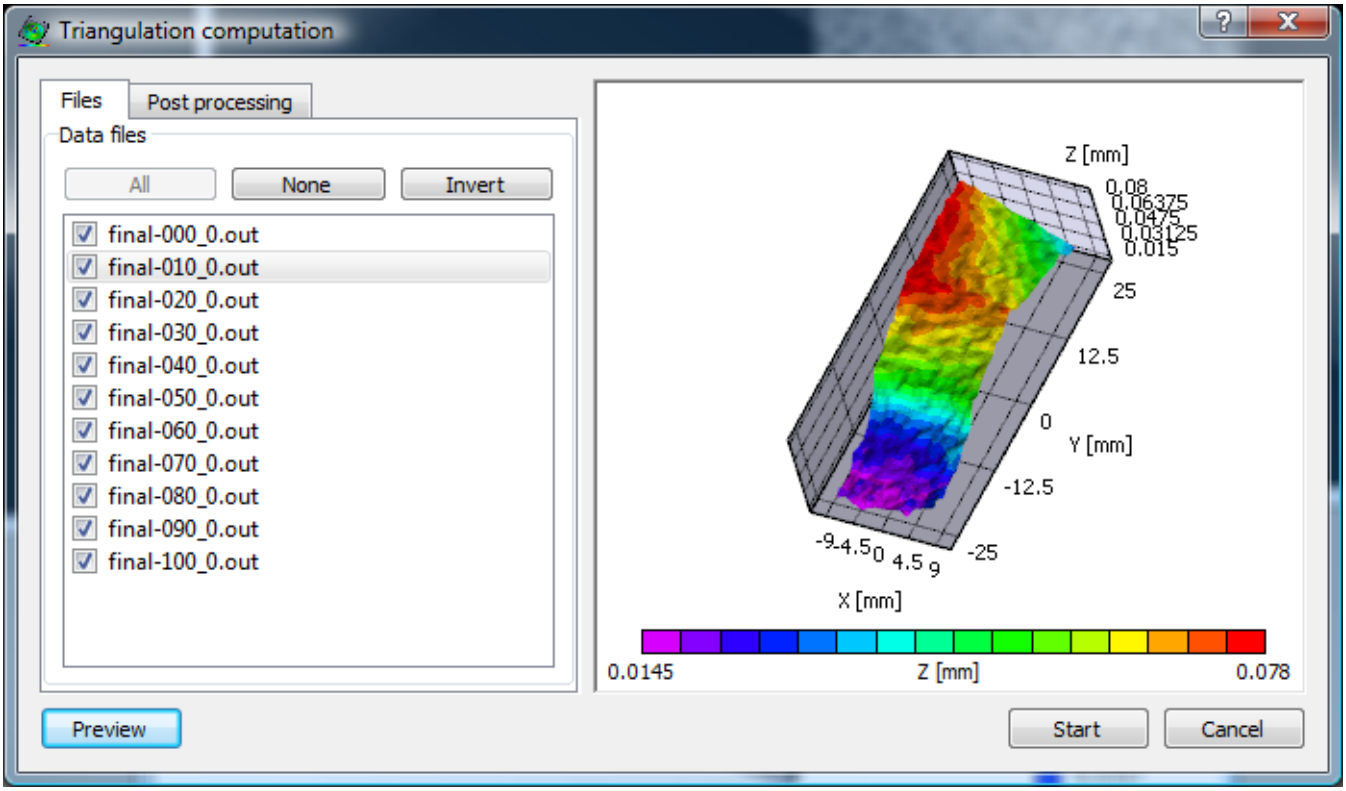
Define Options

Defining options is not necessary but it can be helpful; for instance, a preselected group of material property constants, as in the example below. There are two values for each option: a description and a value.


Edit EqConstant
Define Options
Specify options.
Options:
Description
Value
Titanium
1.1e+11
Copper
1.17e+11
Steel
2e+11
Aluminum
6.9e+10
Add an option...
Finish
Cancel

Retriangulating Data

After data has been manipulated through math operations or postprocessing, it is possible to restore the initial position and displacement field without rerunning the correlation. To start, select *Restore data* from the postprocessing menu or toolbar.



Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

Postprocessing

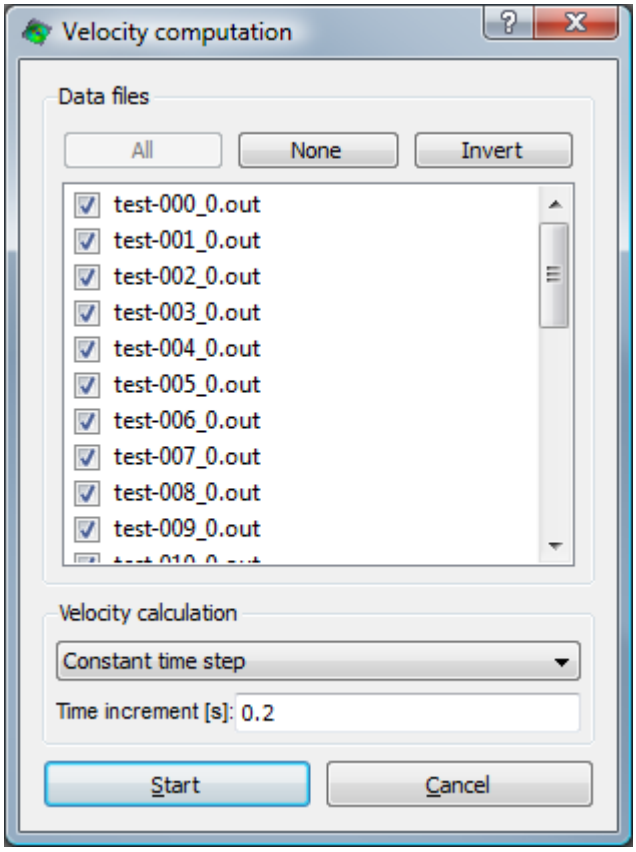
This tab contains the same postprocessing options as the initial Run dialog. Select the coordinate transform, confidence margin option, and strain calculation here.

To complete the operation, click **Start** to restore the data.

Calculating Velocity

Vic-3D can calculate rates for displacement and strain, using either a specified time interval or time retrieved from a .CSV log file.

Once the displacement fields have been calculated from the speckle images, velocities may be calculated by selecting the *Calculate Velocity* entry on the *Data* menu. (If strain rates are desired, strain should be calculated before opening the *Calculate Velocity* dialog.) This will display the dialog shown in the figure below.



Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

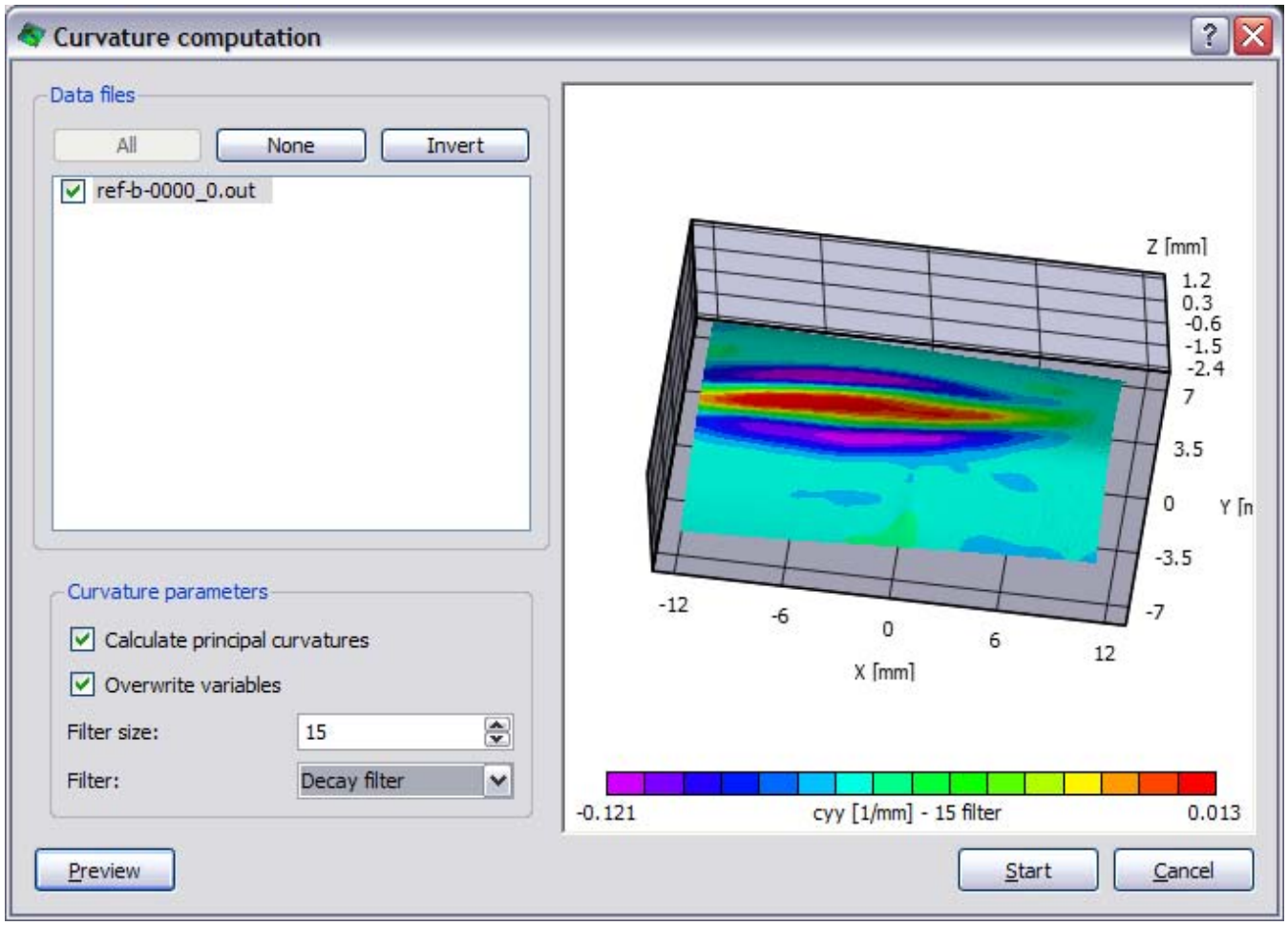
Velocity Calculation

If a Vic-Snap .CSV log file exists for the project, you may select "Time From File" from the dropdown and select the file, if necessary. Otherwise, select "Constant Time Step" and enter the known time increment, or select "Constant Frame Rate" to enter a known frame rate, for, i.e., a high-speed camera.

Click Start to begin; the progress bar will indicate completion. For each strain and displacement variable in the dataset, a derivative in time will be added and can be viewed as a contour overlay.

Curvature Calculation

To calculate local curvature for a set of data, select *Data... Postprocessing options... Calculate strain* from the main menu.



Selecting Data Files for Processing

The available data files are displayed in the *Data Files* list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

Preview

To view the effects of the calculation for a single data file, highlight the file and click the *Preview* button. You may view the plot in 2D or 3D as with a standard data plot.

Calculate principal curvatures

Check this box to add principal curvatures to the x/y curvature data.

Overwrite variables

Check this option to overwrite any existing curvature calculations. If this box is clear, more data fields will be added to the output data set each time strain curvature is calculated.

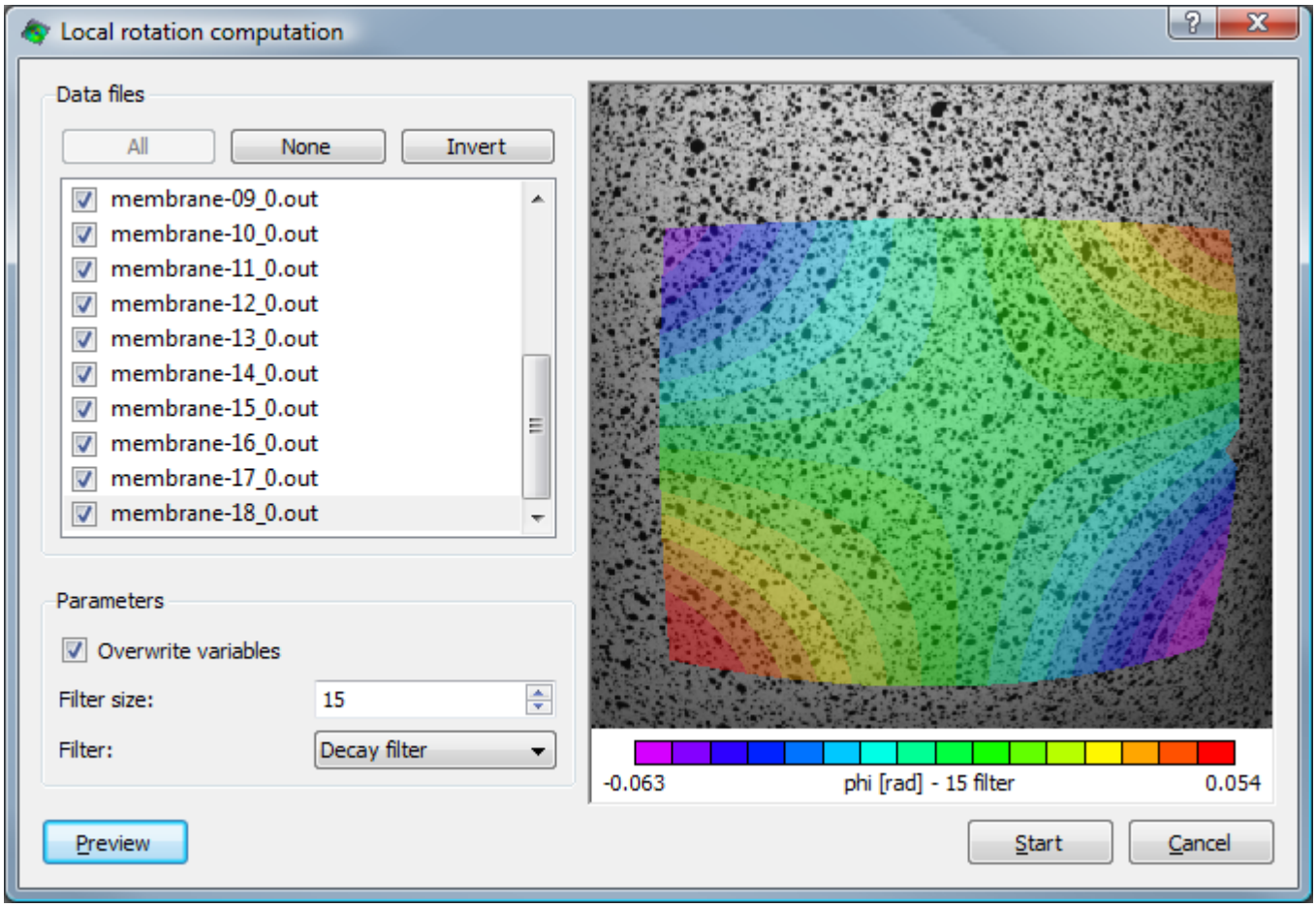
Filter size/type

Calculated curvatures are using a local filter. The *Filter* box allows selection of a smoothing method. The decay filter is a 90% center-weighted Gaussian filter and works best for most situations; the box filter is a simple unweighted averaging filter.

The *Filter size* box controls the size of the smoothing window. Since the filter size is given in terms of data points rather than pixels, the physical size of the window on the object also depends on the step size used during correlation analysis.

Rotation Calculation

To calculate local in-plane rotation for a set of data, select *Data... Postprocessing options... Calculate in-plane rotation* from the main menu.



Selecting Data Files for Processing

The available data files are displayed in the *Data Files* list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

Preview

To view the effects of the calculation for a single data file, highlight the file and click the *Preview* button. You may view the plot in 2D or 3D as with a standard data plot.

Overwrite variables

Check this option to overwrite any existing rotation calculations. If this box is clear, more data fields will be added to the output data set each time rotation is calculated.

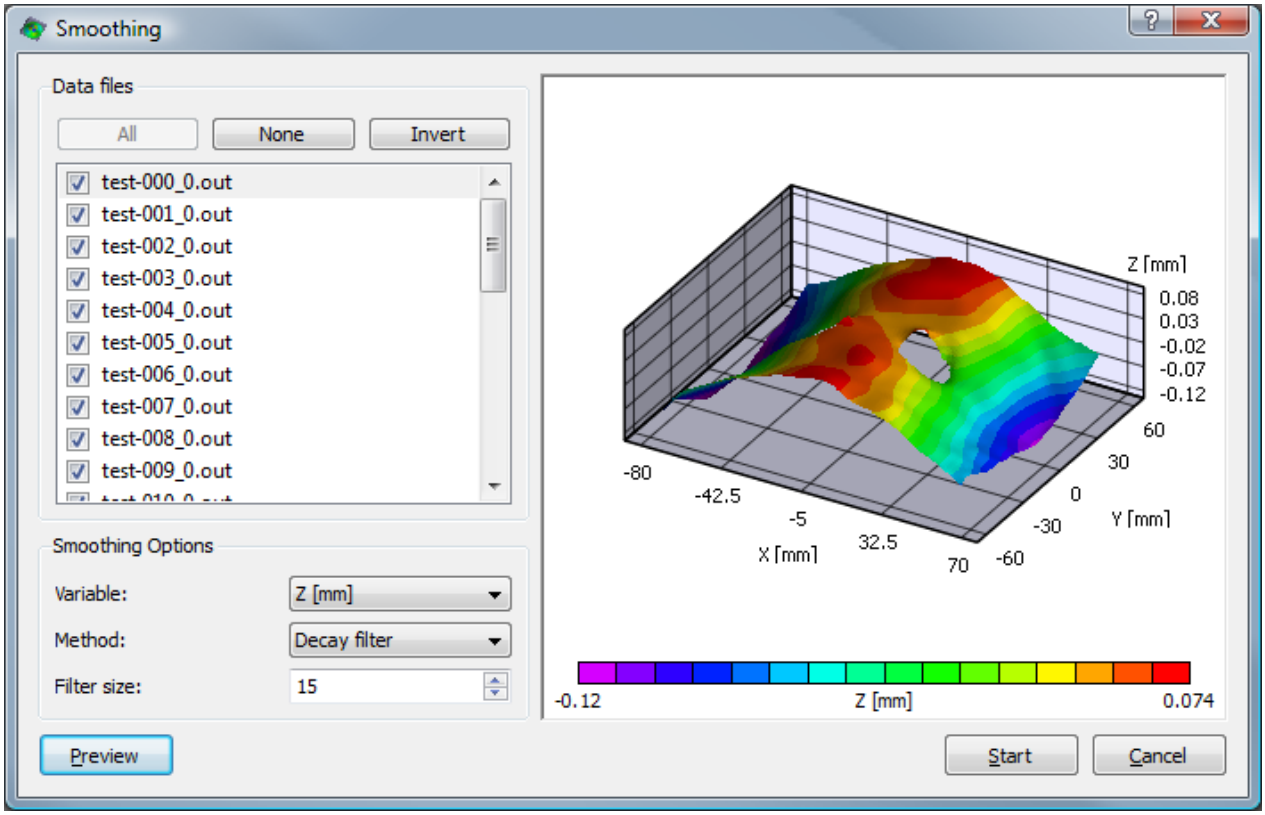
Filter size/type

Calculated rotations are smoothed using a local filter. The *Filter* box allows selection of a smoothing method. The decay filter is a 90% center-weighted Gaussian filter and works best for most situations; the box filter is a simple unweighted averaging filter.

The *Filter size* box controls the size of the smoothing window. Since the filter size is given in terms of data points rather than pixels, the physical size of the window on the object also depends on the step size used during correlation analysis.

Smoothing data

To calculate strain for a set of data, select *Data... Postprocessing options... Smooth variable* from the main menu.



Selecting Data Files for Processing

The available data files are displayed in the *Data Files* list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

Preview

To view the effects of the calculation for a single data file, highlight the file and click the *Preview* button. You may view the plot in 2D or 3D as with a standard data plot.

Filter size/type

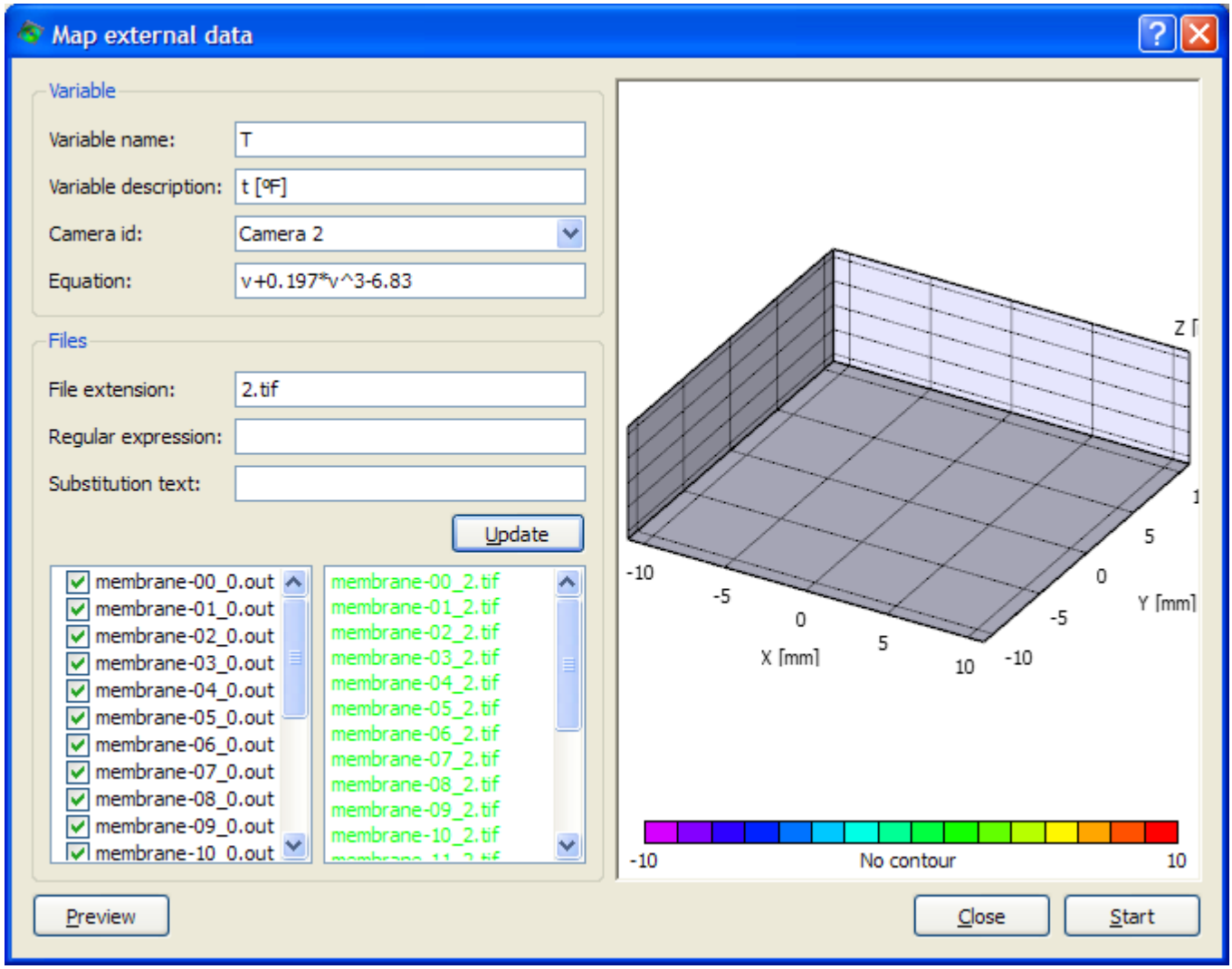
Data is smoothed using a local filter. The *Method* box allows selection of a smoothing method. The decay filter is a 90% center-weighted Gaussian filter and works best for most situations; the box filter is a simple unweighted averaging filter.

The *Filter size* box controls the size of the smoothing window. Since the filter size is given in terms of data points rather than pixels, the physical size of the window on the object also depends on the step size used during correlation analysis.

Note: by default, 3D plots display deformed data - the sum of each point's X,Y,Z location and its U,V,W displacement. Because of this, creating a smooth 3D plot like the one above requires smoothing both Z and W.

Mapping External Data

The software supports mapping of externally acquired data from calibrated area sensors onto data files, e.g., to provide full-field temperature distribution data using infrared cameras. The mapping process requires a calibration for the external camera that is properly registered with the stereo system calibration. In order to ensure that the external camera is registered to the same coordinate system, at least one of the calibration target images must be acquired in the same orientation and chosen as the reference during the calibration process. See camera calibration for details. To map externally acquired area data onto a data sequence, select *Data... Postprocessing options... Map external data* from the main menu.



Output variable

Enter a unique label for the variable name, e.g., *T* for a temperature value, as well as a description of the variable, e.g., *T [Fahrenheit]*.

Camera ID

Select the camera ID that you assigned during calibration of the external area sensor.

Equation

The values read from the data or image file acquired by the external sensor are passed through an equation. The value read from the data file can be accessed through the variable *v* in the equation. The default equation is simply *v*, i.e., the values read from the file are used unmodified. For details on the equation syntax, please refer to equation format.

File name mapping

In order to locate the image or data file acquired by the external camera that corresponds to a given data file, you have to enter the file extension of the image/data files, and character substitutions if applicable.

Note: It is highly recommended to adopt a naming scheme for external data that is consistent with the Vic-3D file naming conventions. E.g., if the base name for the images is *tension*, the Vic-3D image files will be named *tension-xxx_0.tif* and *tension-xxx_1.tif* for the first and second camera, respectively. It is recommended to store the images from the external sensor as *tension-xxx_2.tif* or *tension-xxx_0.mat*, depending on the file format.

If the above recommendation is used, it is sufficient to enter the file extension preceeded by the camera ID in the *File extension* field, e.g., *2.tif* or *2,mat.*

Regular Expression and Substitution Text

A regular expression can be used to match any part of the data file name with the purpose of substituting it. For example, if the data files from Vic-3D are named *tension-xxx_0.out* and the external data files are named *temperature-xxx_2.mat*, enter *tension* in the regular expression field and *temperature* in the substitution text field.

Update

The *Update* button can be used to verify that the files from the external sensor can be located properly. When the update button is clicked, the software will populate the list box to the right of the data file list box with the corresponding image file names from the external camera. Existing files will be shown in green, while missing files are shown in red.

Selecting Data Files for Processing

The available data files are displayed in the list box on the bottom left of the dialog. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

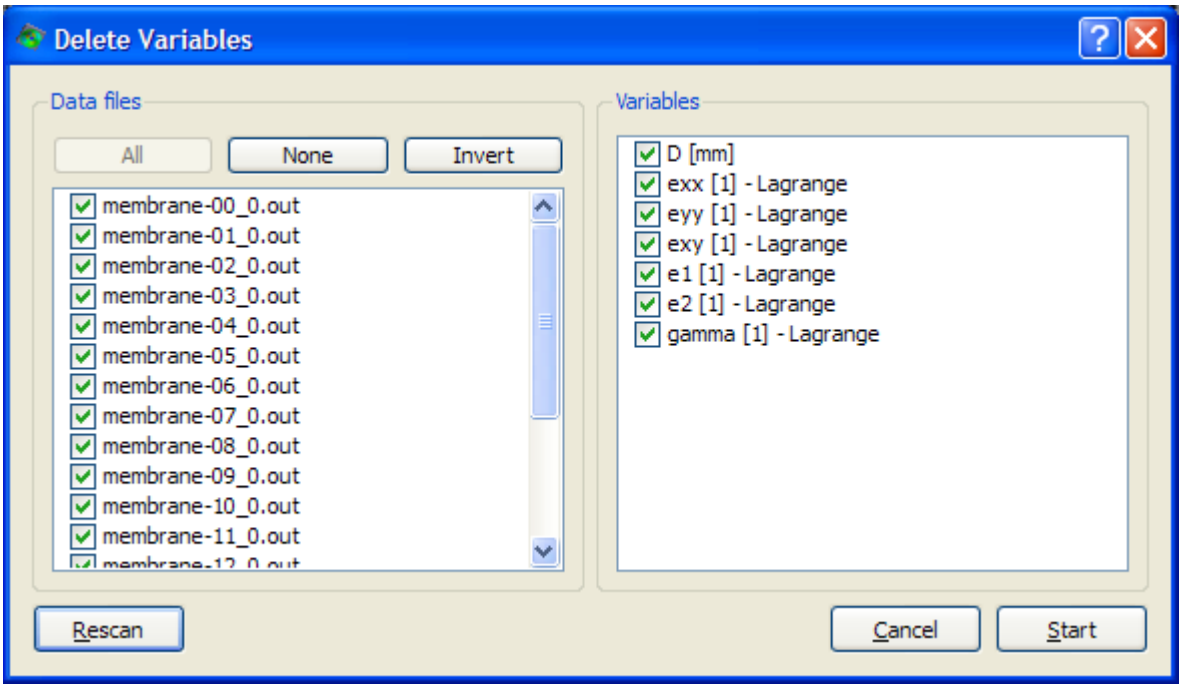
Preview

To view the effects of the calculation for a single data file, highlight the file and click the *Preview* button. You may view the plot in 2D or 3D as with a standard data plot.

Deleting Variables

User-generated variables can be deleted from data files. **Note:** Use this functionality with caution. Once removed, variables cannot be restored other than by reprocessing.

To remove variables from data files, select *Data... Postprocessing options... Map external data* from the main menu.



Selecting Data Files for Processing

The available data files are displayed in the list box on the left of the dialog. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files, while *Invert* reverses your selection.

Selecting Variables

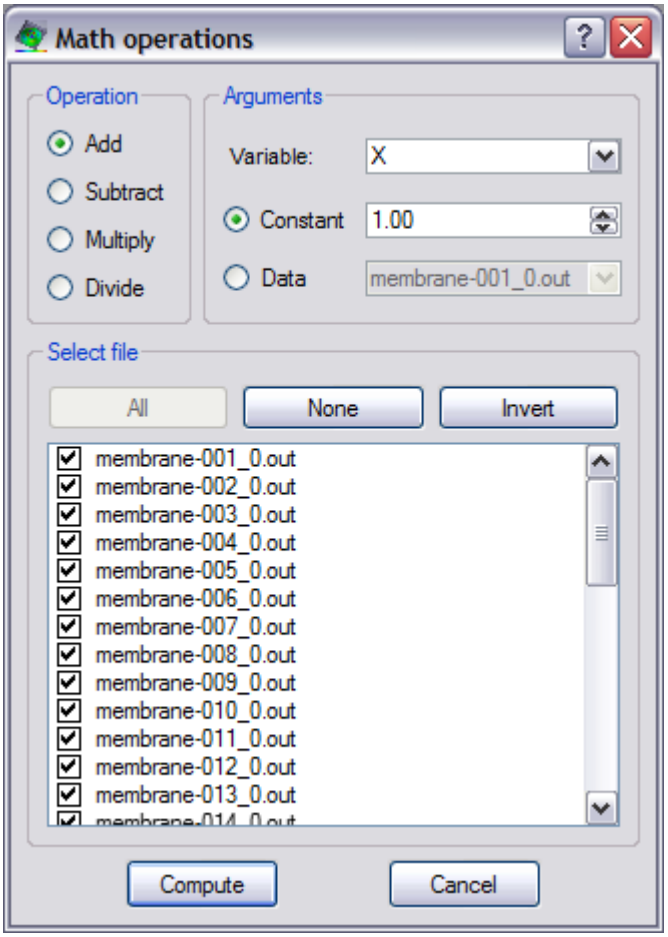
The available variables are listed in the list box on the right of the dialog. Note that only user-generated variables can be deleted. Select the variables you wish to remove by clicking on the variable name. This will toggle a check mark indicating whether the variable will be removed or not.

Rescanning Variables

If the data files do not all contain the same variables, the variable you are trying to remove may not appear in the list box when the dialog is shown. In this case, highlight the data file that contains the variable you wish to remove in the data file list box by clicking on it. Then, press the *Rescan* button to repopulate the variable list box based on the variables contained in the selected data file.

Math Operations

The *Math operations* dialog allows manipulation of output data by basic math operations. Open this dialog by selecting *Data... Math Operations* from the main menu bar.



Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

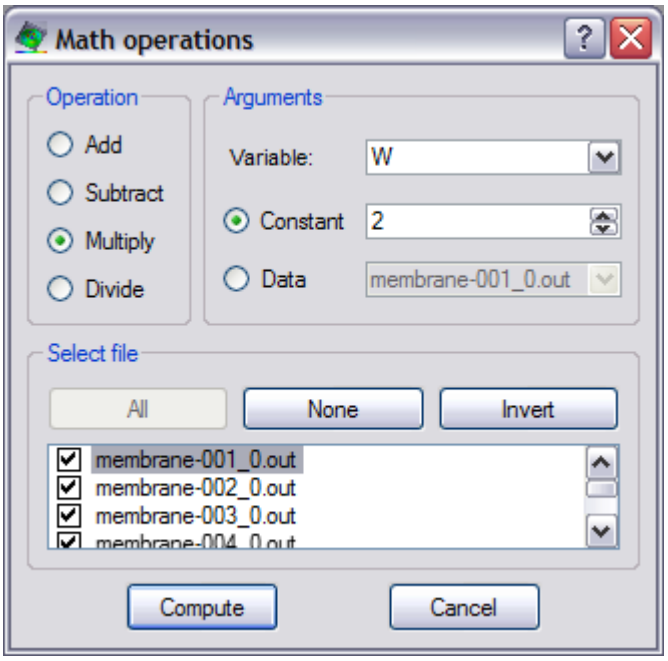
Operation

Choose Add, Subtract, Multiply, or Divide to perform the specified operation.

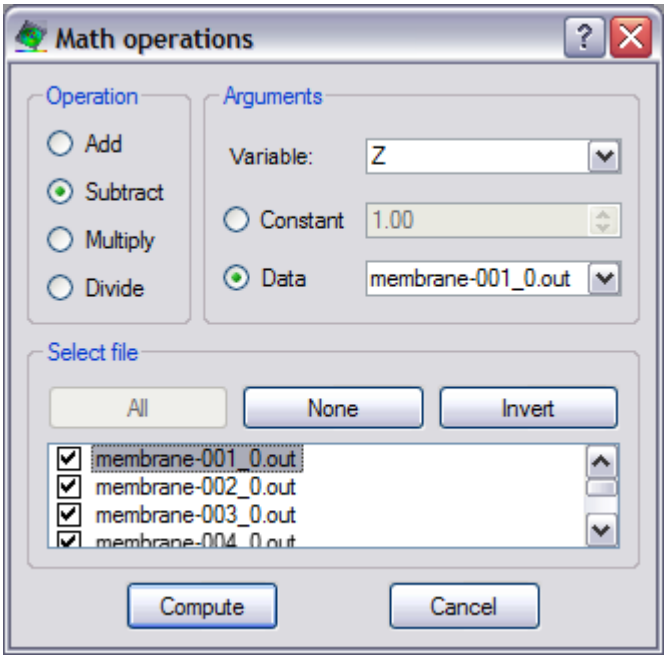
Arguments

The *Variable* box is used to select the variable to operate on. Any variable in the data set may be selected.

To use a constant argument, select the *Constant* radio button and enter the value. For example, the selections below will multiply the W-displacement value from each data file by 10.



To use the data from an output file, click *Data* and select a data file. For example, the selections below will subtract the Z shape from the first data file, from all data files.



Click Start to begin; the progress bar will indicate completion. For each strain and displacement variable in the dataset, a derivative in time will be added and can be viewed as a contour overlay.

Export options

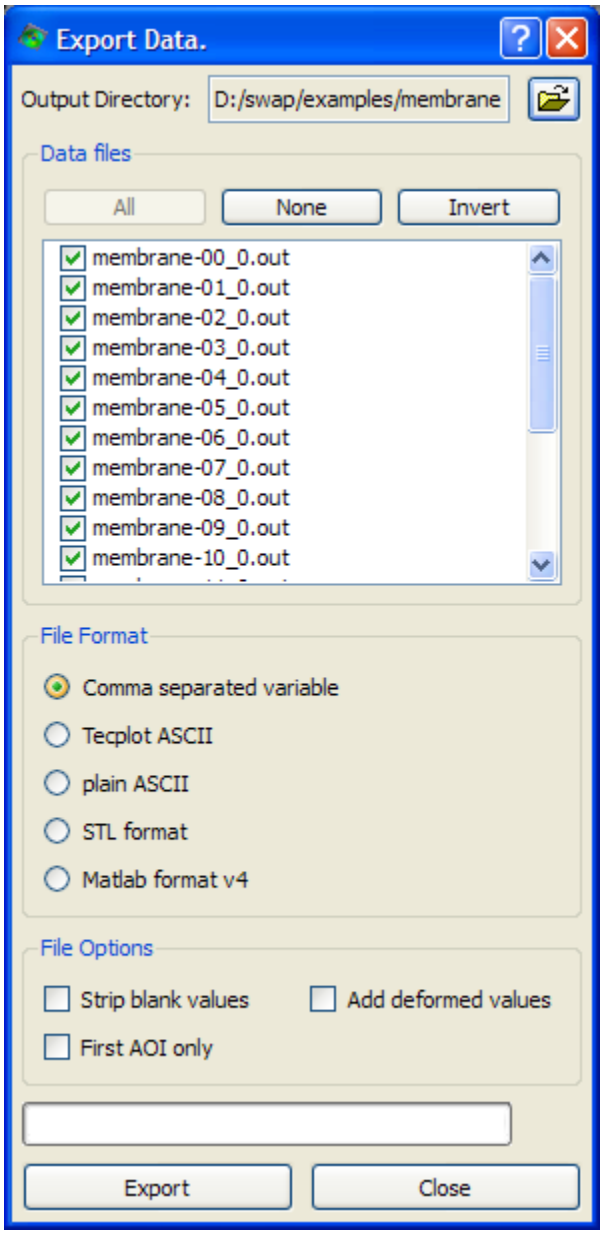
Calculated position and displacement data, along with transformed and postprocessed variables, can be exported via several different options:

- **All data -** export entire data set
- **Pixel grid data** - sample data set on a pixel grid
- **Metric node data -** place surface nodes using metric coordinates, for FE comparisons
- **Aggregate statistics** - export mean, median, deviation, min, max for selected files and variables

Exporting Data

For efficient file access, Vic-3D stores results in a binary data file format. To use the data with other programs for post-processing and plotting, the data can be exported by selecting the *Export* item from the *Data* menu.

The dialog shown below will be displayed.



Selecting Files for Exporting

The available data files are displayed in the list box. To select which files to export, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files.

File Formats

The data files can be exported to the following formats:

Comma-Separated Variable

Data entries are separated by commas. This format is understood by most spreadsheet programs and plotting packages. Variable names are stored in the data file as comma-separated strings in quotation marks. Exported files will have the extension *csv*.

Tecplot

Used for plotting the data with *Amtec's* (www.amtec.com) plotting program *Tecplot(TM)*. Exported files will have the extension *dat*.

Plain ASCII

This format is plain, space-delimited ASCII text data with one data point per line. Note: There are no variable names in the data file, and data from different AOIs is concatenated. Exported files will have the extension *txt*.

STL Format

This format provides a triangulated surface compatible with many CAD programs.

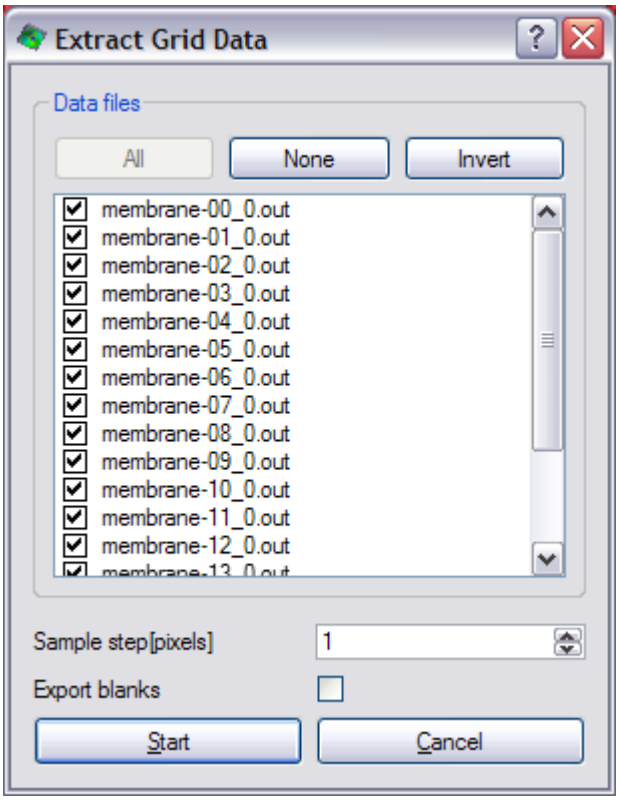
Matlab V4

This format provides compatibility with Matlab and many other programs capable of reading Matlab files. Note that if multiple AOIs are present in a datafile, unique names for each of the matrices are generated by appending increasing numbers to the variable names. For instance, the X-coordinate for the first AOI will appear as *X* in the matlab file, and for the second AOI it will appear as *X_0* and so forth.

If none of the available file formats fit your needs, please contact support@correlatedsolutions.com. We will gladly implement data exporting to a format that best suits your needs.

Exporting Grid-Based Data

This option can be used to export your data, sampled at regular intervals spatially and for each data file, to a single text file. To begin, select *Export Grid Data* from the *Data* menu.



Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

Options

To change the sample interval in pixels, adjust the *Sample step* value. A value of 1 will sample every pixel; higher values will result in a sparser data set.

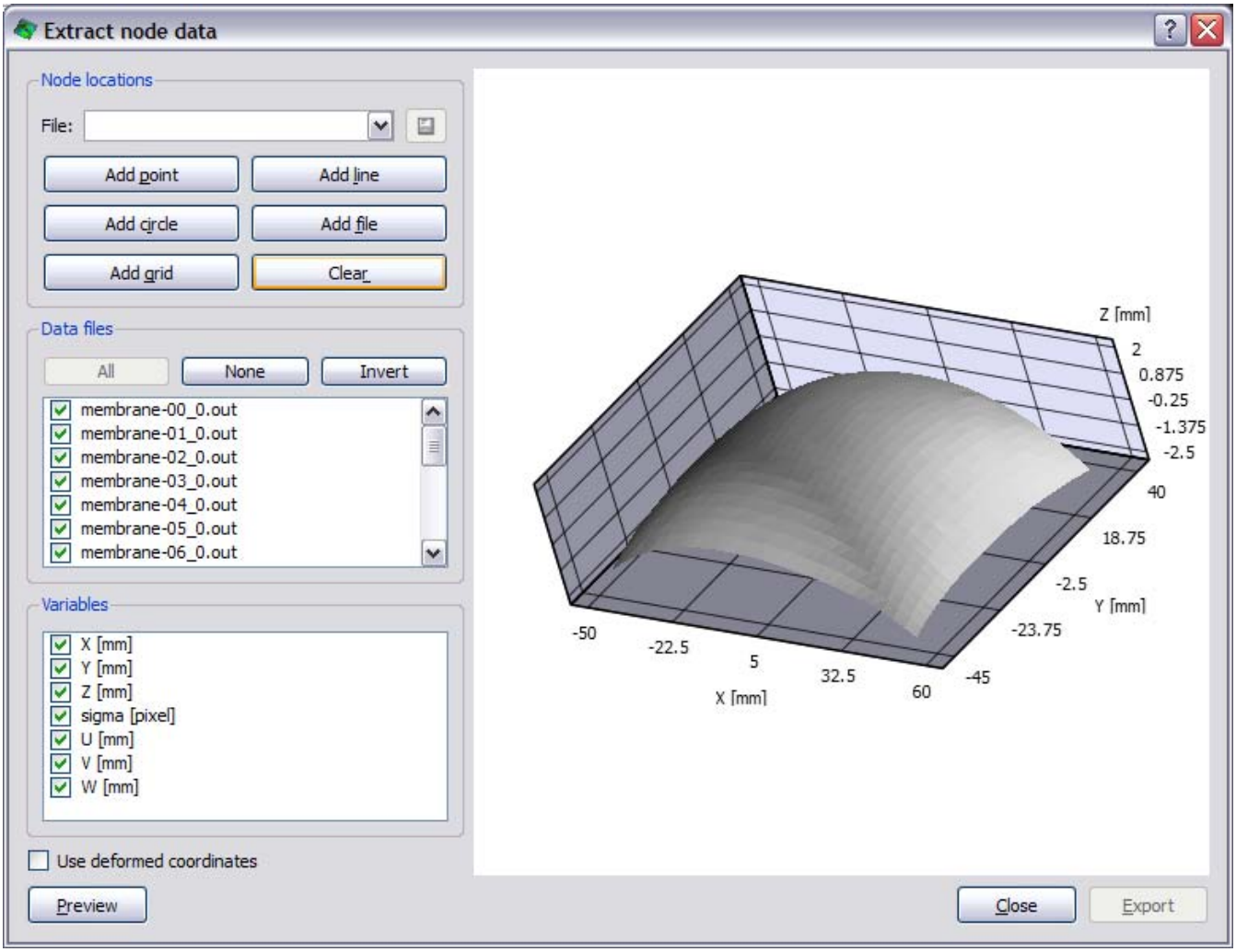
To export blank values to the output file, with a value of 0, check the *Export blanks* box. If this box is cleared, blank data points will not be present in the output file.

Extracting Data

To begin, click *Start*. You will be prompted for an output .csv file name. A progress bar will appear; when extraction is complete, the dialog will close.

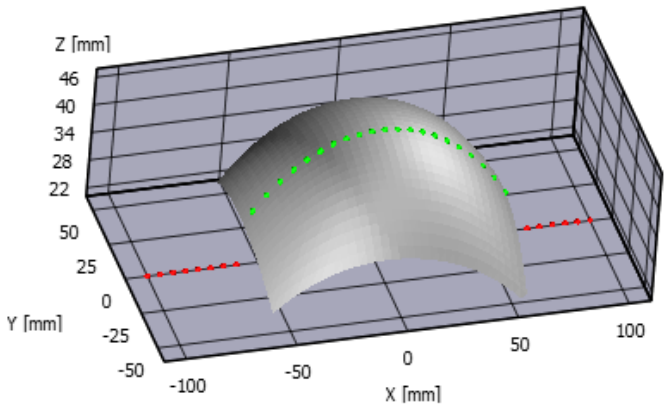
Extracting Node Data

This option can be used to export spatially sampled data to one or more CSV files.



Adding sample points

Exported data is sampled based on X, Y coordinates. You can add a single point at a time, or a line, circle, or grid, by clicking on the appropriate button. This can be repeated as many times as desired to add as many points as necessary. Points on the surface will be displayed as green markers; points which do not fall on the surface for a given data file are shown as red.



To save a set of points for future use, click the disk icon next to the file dropdown. To restore from an existing file, use the file dropdown, or select **Add File** .

Data files

Use this list to select one or more data files to extract from.

Variables

Select the desired output variables from this list.

Use deformed coordinates

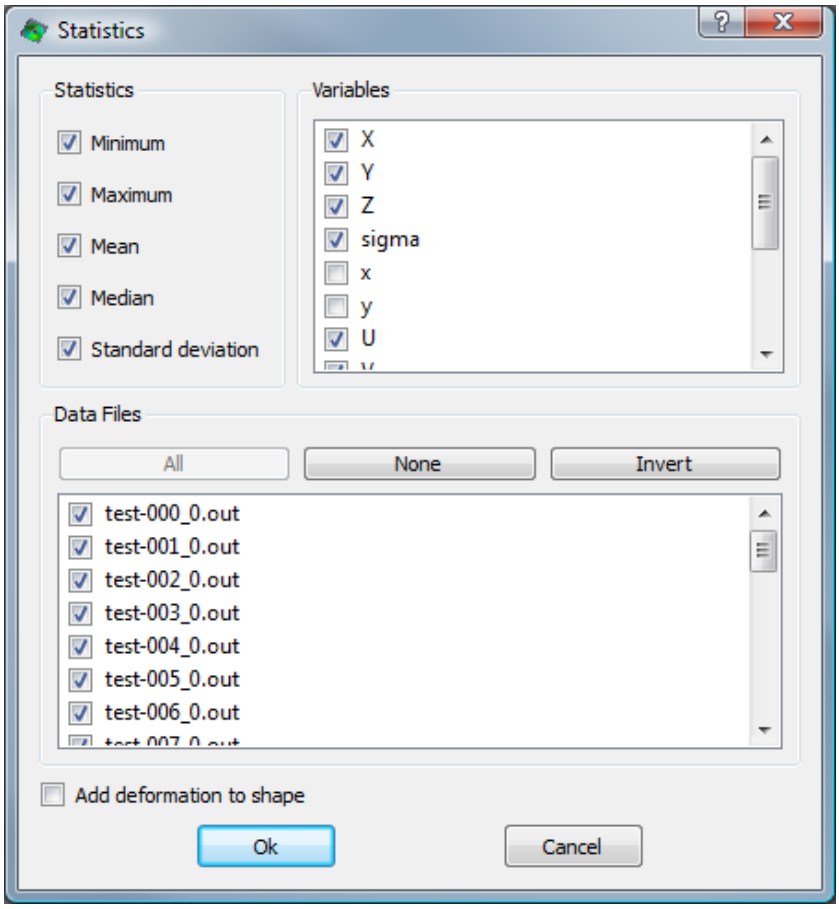
To overlay the selected X, Y points on the *deformed* shape, check this box. To overlay the coordinates on the *initial* shape (while still exporting deformation data), clear the box.

Preview and Export

Click **Preview** to see the position of your points on the selected file. To export the data according to your selected points, click **Export.**

Calculating Statistics

To export statistics for calculated variables and data files, select *Data... Statistics* from the main menu bar.



Statistics

Check the desired item to include or exclude the statistic from the output file.

Variables

Check the desired variables to add them to the calculation. By default, all metric variables are included, while correlation and pixel variables are excluded.

Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

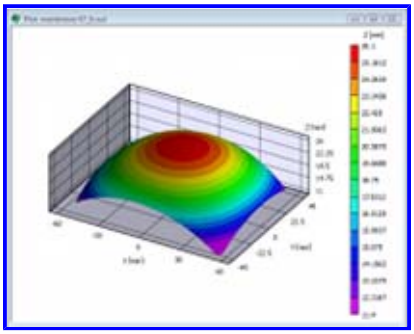
Exporting

To complete the calculation, click *Ok*. You will be prompted for a filename, and the data will be exported as a .CSV file.

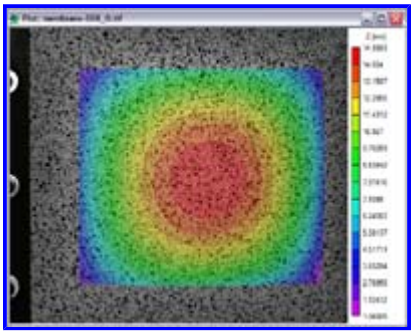
Plotting Data

Data can either be visualized as a three-dimensional plot with or without color contour overlay, or as a two-dimensional contour plot overlayed over the speckle image. The two-dimensional plot provides facilities for extracting data from sequences, as well as extracting slices of data.

3D Plot



2D Plot



Output Variables

Introduction

During correlation and optional post-processing, Vic-3D presents a wide range of output data available for 3D and contour plotting, extraction, and export.

Output Variables

Always Present

- X [mm] - metric position along the X-axis (by default, the horizontal axis).
- Y [mm] - metric position along the Y-axis (by default, the vertical axis). Z [mm] - metric position along the Z-axis (by default, the out-of-plane axis).
- sigma [pixel] - this is the confidence interval for the match at this point, in pixels.
- x / y [pixel] - point location in the reference speckle image
- U [mm] - metric displacement along the X-axis, from the reference image. For the reference image, displacement values will always be 0.
- V [mm] - metric displacement along the Y-axis.
- W [mm] - metric displacement along the Z-axis.
- u / v / q / r [pixel] - internal raw disparity measures.

Generated in Postprocessing

Strain Variables

- exx [1] - strain in the X-direction. Positive numbers indicate tension; negative numbers indicate compression.
- eyy [1] - strain in the Y-direction.
- exy [1] - shear strain.
- e1 [1] - the major principal strain.
- e2 [1] - the minor principal strain.
- gamma [1] - the principal strain angle in radians, measure counterclockwise from the positive X-axis.

Velocity Variables

- dU/dt [mm/s] - the rate of change of the U-displacement; that is, the velocity of a given point in the X direction.
- dV/dt [mm/s] - velocity in the Y direction.
- dW/dt [mm/s] - velocity in the Z direction.
- dExx/dt [1/s] - the rate of change of strain in X, or strain rate in X.
- dEyy/dt [1/s] - the strain rate in Y.
- dExy/dt [1/s] - the shear strain rate.

Curvature Variables

- cxx [1/mm] - curvature in the X-direction, equivalent to 1/(diameter of curvature).
- cyy [1/mm] - curvature in the Y-direction.
- c1 [1/mm] - the major principal curvature.

- c2 [1/mm] - the minor principal curvature.
- gamma [1] - the principal curvature angle in radians, measured counterclockwise from the positive X-axis.

Rotation Variables

- phi [1] - the in-plane rotation, in radians.

Key Terms

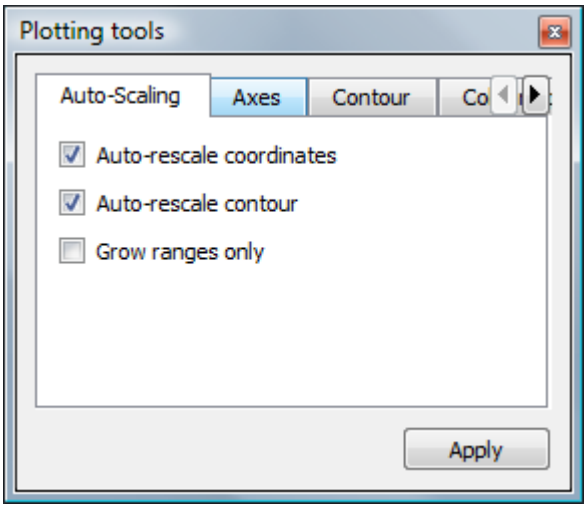
Strain: the change in length, divided by initial length, for a solid material. For example, a strain of +10% indicates that the material has expanded by 10%; a strain of -10% indicates that the material has contracted by 10%. Positive strains are referred to as tensile, while negative strains are compressive. Note: this is a finite strain tensor and contains a quadratic term; for significant strains, this may result in a strain measure which is larger than the small strain indicated by a strain gauge or extensometer.

Principal strain: the strain for a reference frame that is rotated such that shear becomes zero, leaving only two strain components at 90ï¿½ angles. The larger strain becomes the major principal strain, and the smaller becomes the minor principal strain.

The Plot Toolbar

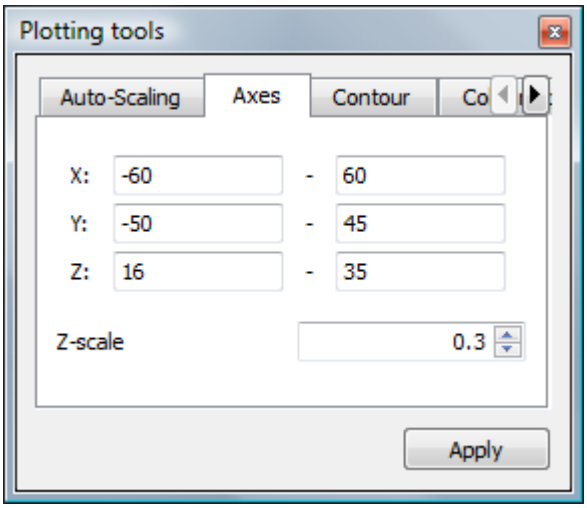
The plot toolbar is displayed at the top left edge of the work area by default. It contains options and controls for both the 2D and 3D plots.

Auto-Scaling



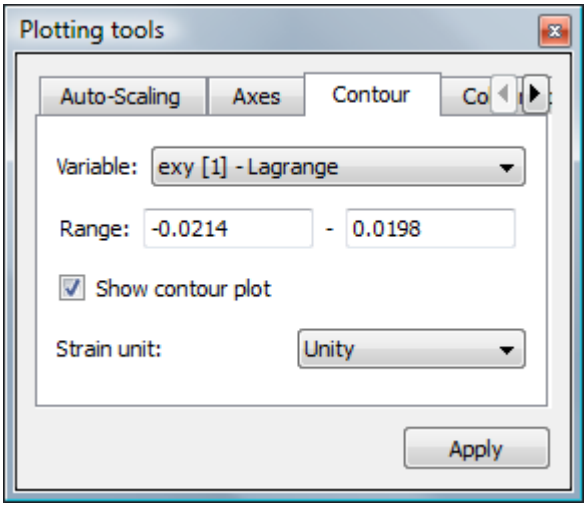
This tab controls auto-scaling. Check or clear the boxes to enable auto-rescaling of either coordinate axes limits, or contour overlay limits. Check *Grow ranges only* to allow ranges to get larger but not smaller. With this box checked, you can animate through all images to set the limits to the minimum and maximum over all data files. This is useful for producing consistent animations and videos.

Axes



This tab allows selection of axis limits and Z-scaling, when auto-scaling is turned off. To control the scaling of the Z-axis relative to the X- and Y-axes, change the *Z-scale* value. Larger numbers will exaggerate the Z-axis more.

Contour

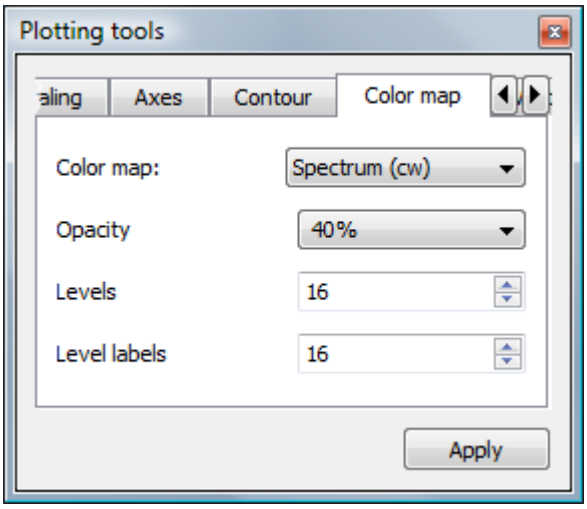


This tab allows control of the contour overlay of 2D or 3D plots. To automatically scale these values to fit the data, check the *Auto-rescale contour* box. To manually set the limits, clear this box and enter the desired values.

To enable or disable the contour overlay in 3D mode, select *Show contour plot.*

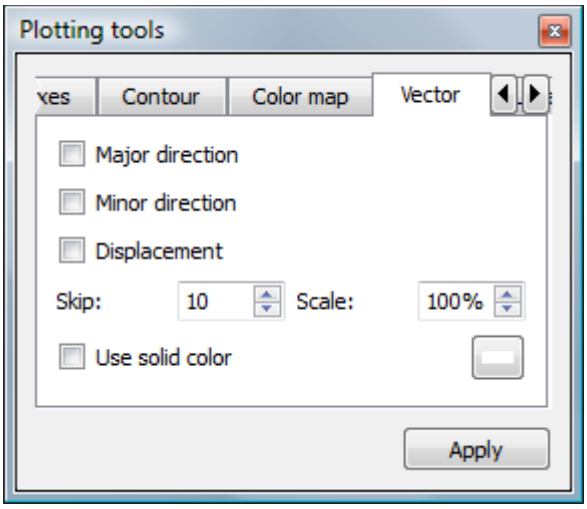
Use the *strain unit* control to determine how strain values are displayed; the default is unity, i.e., mm/mm.

Color



Use this tab to control the display of contour overlays. The *Color map* box chooses the overall color set for the plot. The *Opacity* box sets the opacity of the overlay; this option affects 2D plots only. The *Levels* box sets the n box sets the number of discrete contour levels. The *Level labels* box controls the number of numeric level indicators.

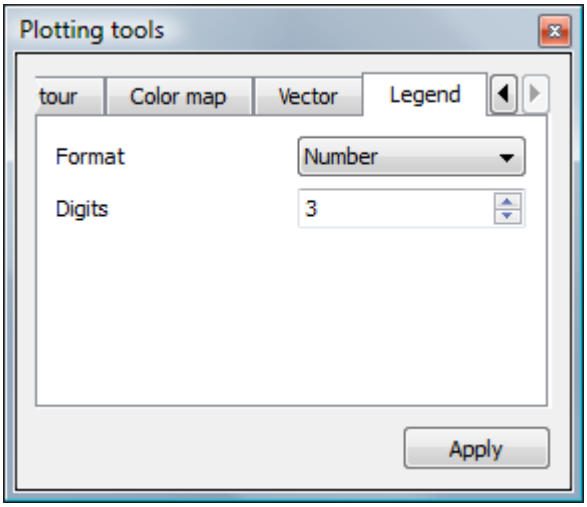
Vector



This tab controls display of strain and displacement vectors.

Major and minor strain direction vectors are displayed on 2D plots only, when strain data is available; displacement vectors may be viewed in 2D or 3D. *Skip* and *scale* control the size and density of the vectors. The *use solid color* checkbox causes the vectors to be displayed in a single color rather than the underlying plot color; the color selector button can be used to choose this color.

Legend

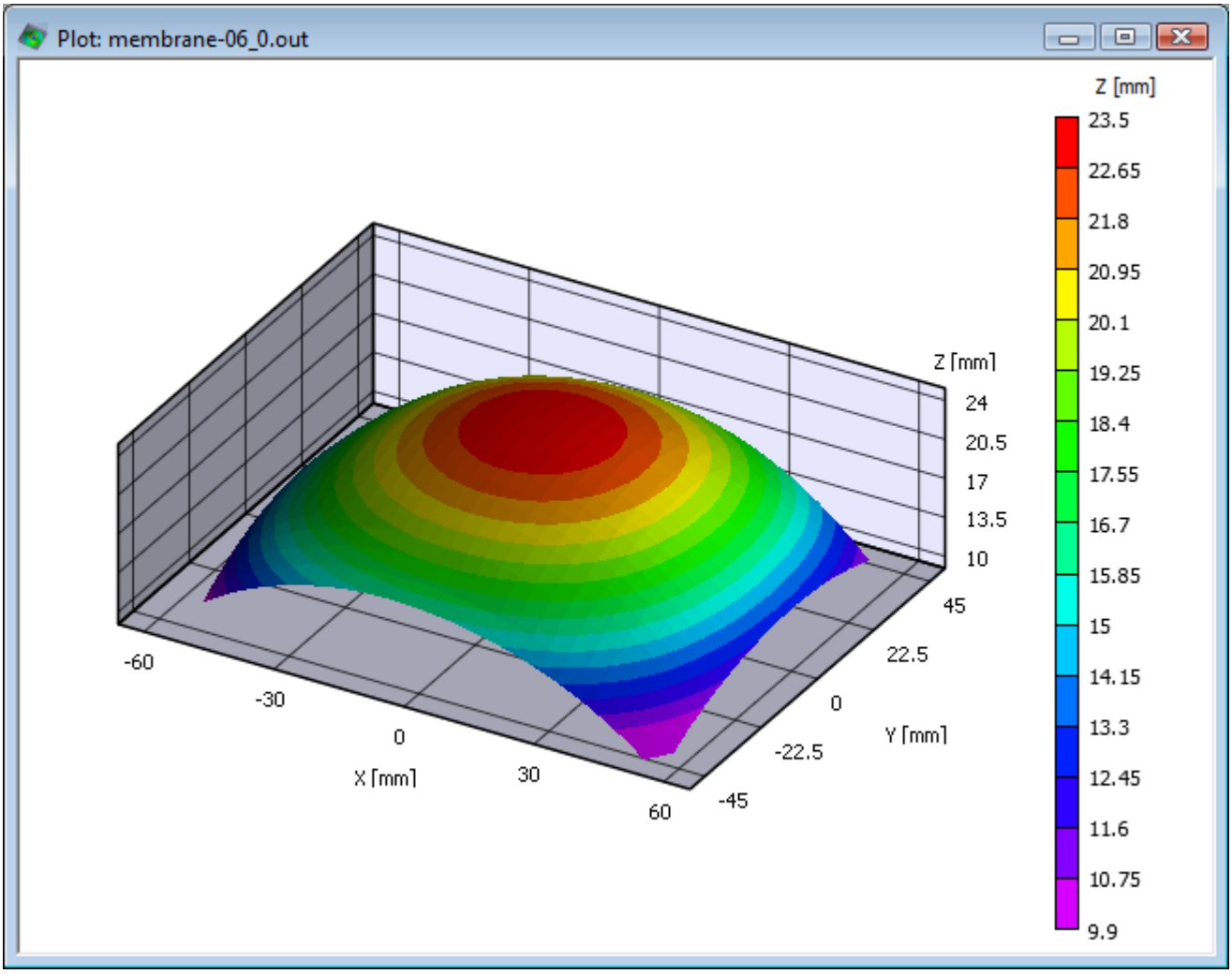


These controls affect the format of the contour legend. Select a *Format* from Number, Scientific (exponential notation), or Best (most concise method). Select a number of *Digits*, or Automatic to use as much precision as necessary.

3D Plots

A 3D plot of the data can be displayed by double-clicking on a data file in the list view to the left of the workspace or by selecting a data file from the *Data... Plot* menu.

A plot will be displayed in the workspace as shown below.

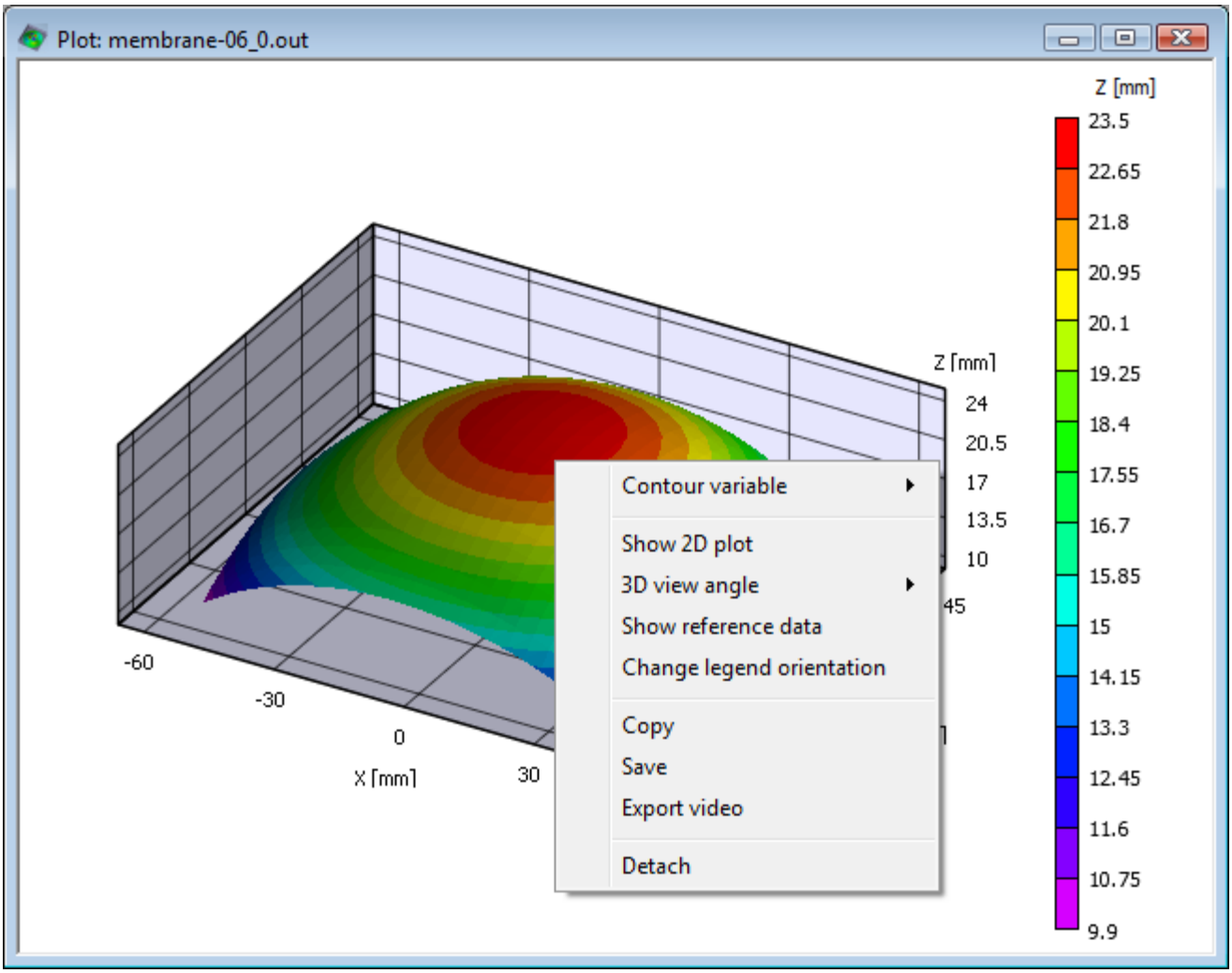


Controlling the Plot

To rotate the plot, click and drag in the plot window. To zoom in and out, rotate the scroll wheel. To pan around the plot, click and hold the scroll wheel and move the mouse.

Plot Options

Plot options can be accessed by right-clicking in the plot window.



To switch to a 2D plot, select *Show 2D Plot* from the context menu, or click *2D* in the main toolbar.

Use the *View* submenu to select a planar view or revert to the default view.

The *Contour variable* submenu can be used to select the variable to display.

Click *Change legend orientation* to toggle between a horizontal and vertical legend.

Copy copies the current plot to the clipboard; *Save* allows saving the plot as an image file.

Select *Export video* to save an animated video.

Click *Detach* to keep this plot static instead of updating it each time a new data file is clicked in the Data tab.

Editing Plot Parameters

To edit other plot parameters, use the plot toolbar.

Animating Plots

To animate 3D plots, bring up the plot display and then use the controls on the Animation Toolbar to animate the sequence.

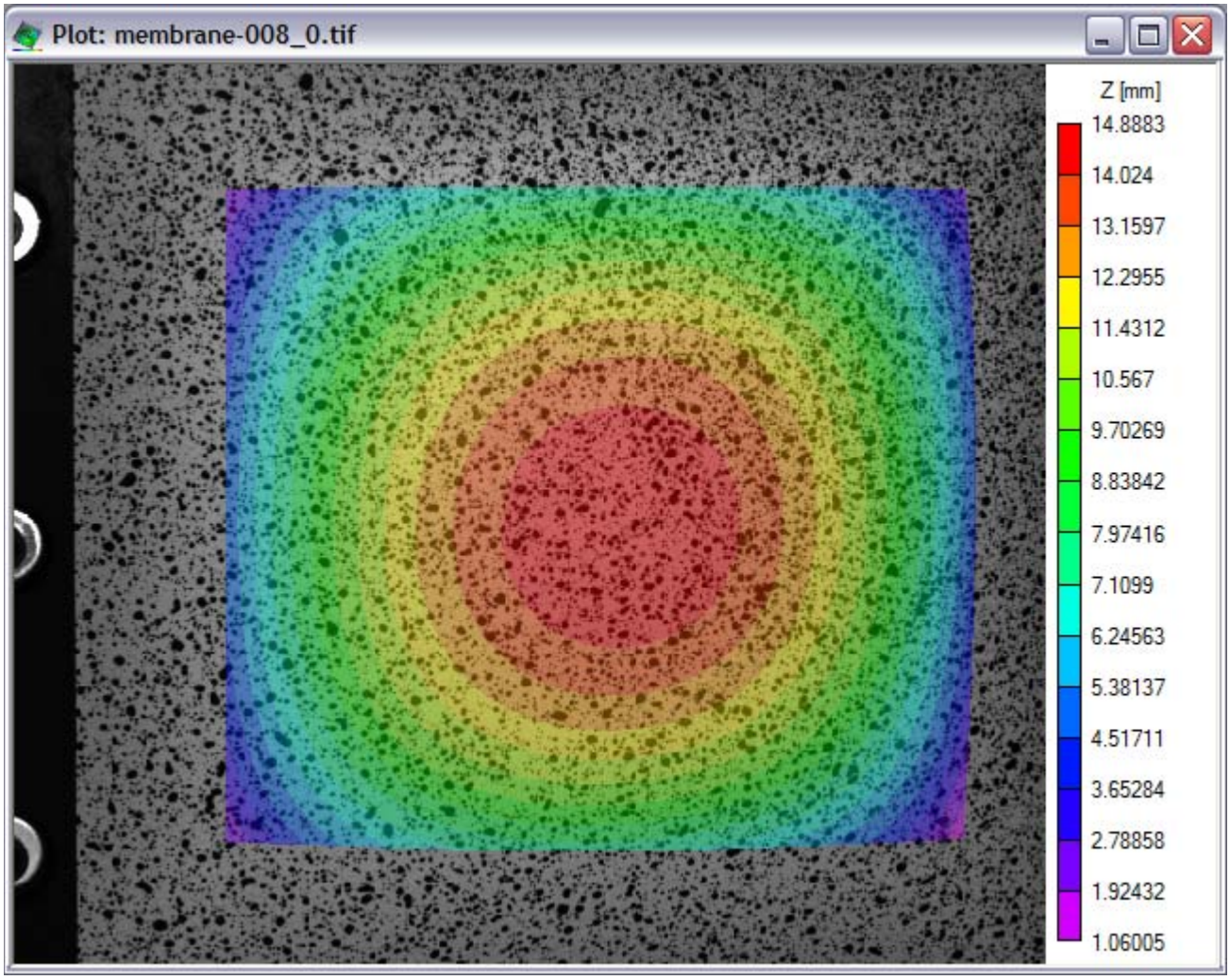
Saving the Plot

The displayed plot can be saved as a BMP, PNG, or JPG image file by selecting *Save* from the context menu. To copy the plot to the clipboard, select *Copy*.

2D Plots

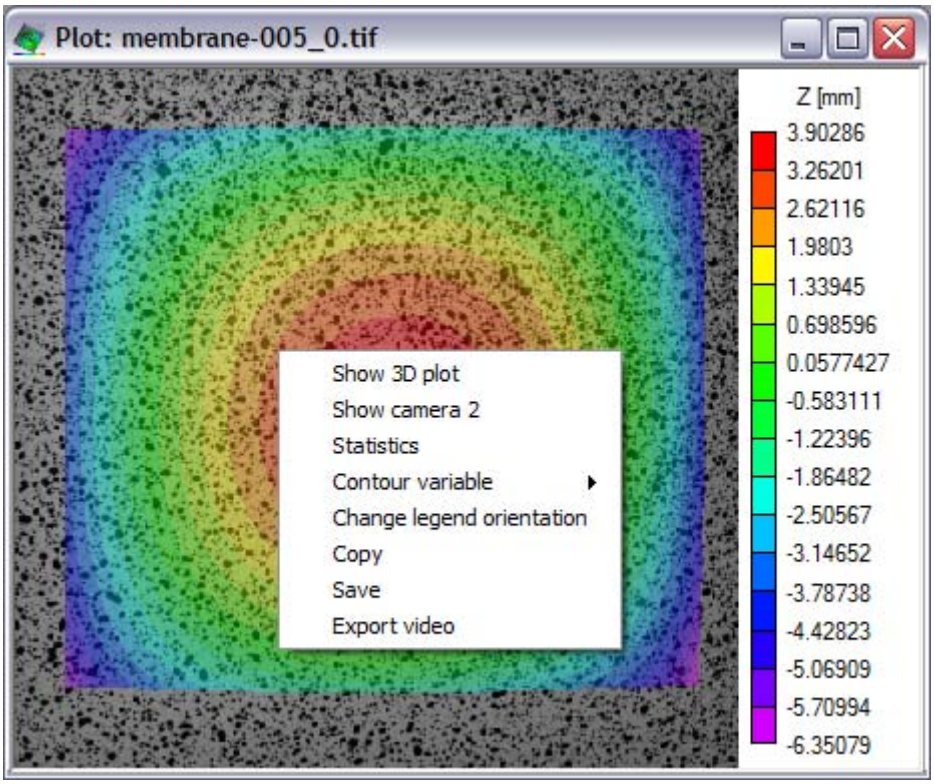
A 2D plot of the data can be displayed by double-clicking on a data file in the list view to the left of the workspace, and then clicking *2D* in the main toolbar or clicking *Show 2D plot* in the plot context menu.

A plot will be displayed in the workspace as shown below.



Plot Options

Plot options can be accessed by right-clicking in the plot window.



To switch to a 3D plot, select *Show 3D Plot* from the context menu, or click 3 *D* in the main toolbar.

Click *Show camera 2* to change the underlying speckle image to the other camera view.

Click *Statistics* to view a summary of data for the current image, for the currently selected contour variable.

The *Contour variable* submenu can be used to select the variable to display.

Click *Change legend orientation* to toggle between a horizontal and vertical legend.

Copy copies the current plot to the clipboard; *Save* allows saving the plot as an image file.

Select *Export video* to save an animated video.

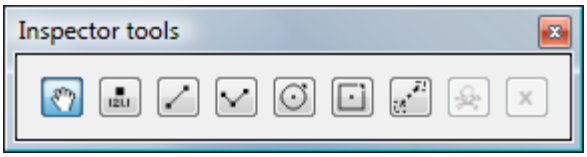
Click *Detach* to keep this plot static instead of updating it each time a new data file is clicked in the Data tab.

Editing Plot Parameters

To edit other plot parameters, use the plot toolbar.

Inspector Tools

Tools for probing and extracting data are located in the Inspector Toolbar, and can also be selected by clicking *Plot... Inspector* in the main menu bar.



From left to right, the tools are:

- Pan/Select: Pans around the contour image, when zoomed in; selects existing extract points. To select an item, click on the small square handle.
- Inspect point: select this tool and click to probe at a single point. The value for the currently selected contour variable, at the chosen point, will be displayed.
- Inspect line: select this tool and click once to start a line; click again to finish. The value will be displayed at each node.
- Inspect polyline: select this tool and click to create line nodes; double-click to finish. The value will be displayed at each node.
- Inspect circle: select this tool and click to define a center; click again to define a disc. The value at the center will be displayed.
- Inspect rectangle: select this tool and click to define a center; click again to define a rectangle. The value at the center will be displayed.
- Extensometer: select this tool and click two points; this tool shows the extension (change in length divided by initial length) between the two points.
- Delete: choose this tool and click on an existing point/line/area to remove it.
- Extract: click to open the Extract Sequence Data or Line Plot dialogs. For the line tool, data will be extracted alone the line for the current image. For the other tools, data will be extracted at the selected point or area, for each image, as a time sequence.

Animating Plots

To animate contour plots, bring up the plot display and then use the controls on the Animation Toolbar to animate the sequence.

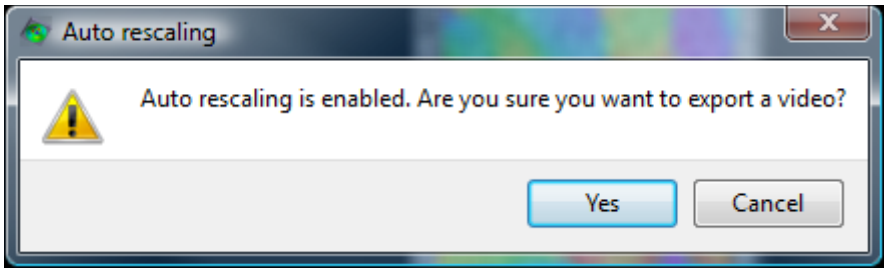
Saving the Plot

The displayed plot can be saved as a BMP, PNG, or JPG image file by selecting *Save* from the context menu. To copy the plot to the clipboard, select *Copy*.

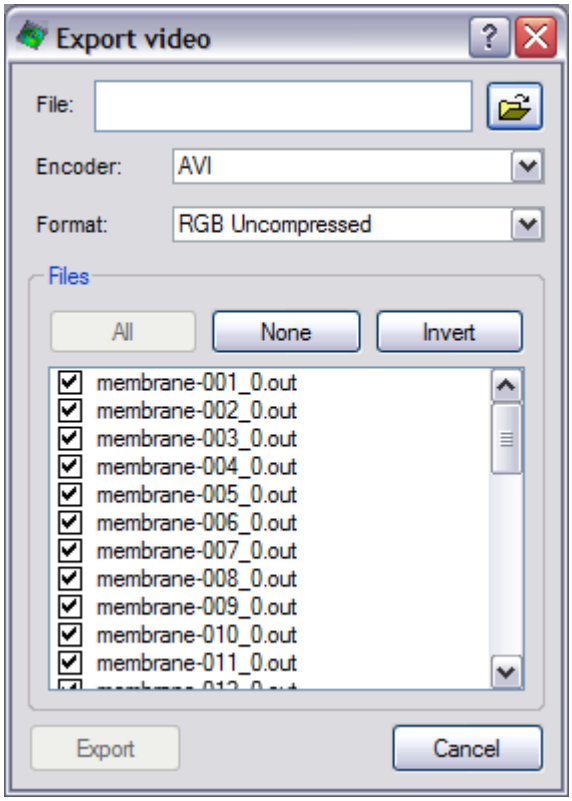
Exporting Videos

To export an animation from a 2D or 3D plot, right-click in the plot and select *Export Video*.

If the auto-rescaling feature is enabled for contours or axes, you will see a warning:



When rescaling is on, the animation may not appear as expected because each frame will be scaled differently. Click *Yes* to continue or *Cancel* to correct the condition. When complete, the following dialog appears:



File

Click the icon to select a filename for saving.

Encoder

To export a video file, select *AVI* from the Encoder drop-down; to export individual frames as separate, numbered files, select *Image Sequence*.

Format

Select from available compression formats; options will vary based on system configuration and installed codecs. Indeo(R) Video 5.11 works well for most Windows XP systems. RGB Uncompressed videos will be high quality but very large.

Data File Selection

The available data files are displayed in the list box. To select which files to process, click on the data file you want to select/deselect. This will toggle the check mark indicating whether the file is selected or not. For convenience, the buttons labeled *All* and *None* select/deselect all files; the *Invert* button inverts the selection.

To begin, click *Export*; a progress bar will indicate completion.

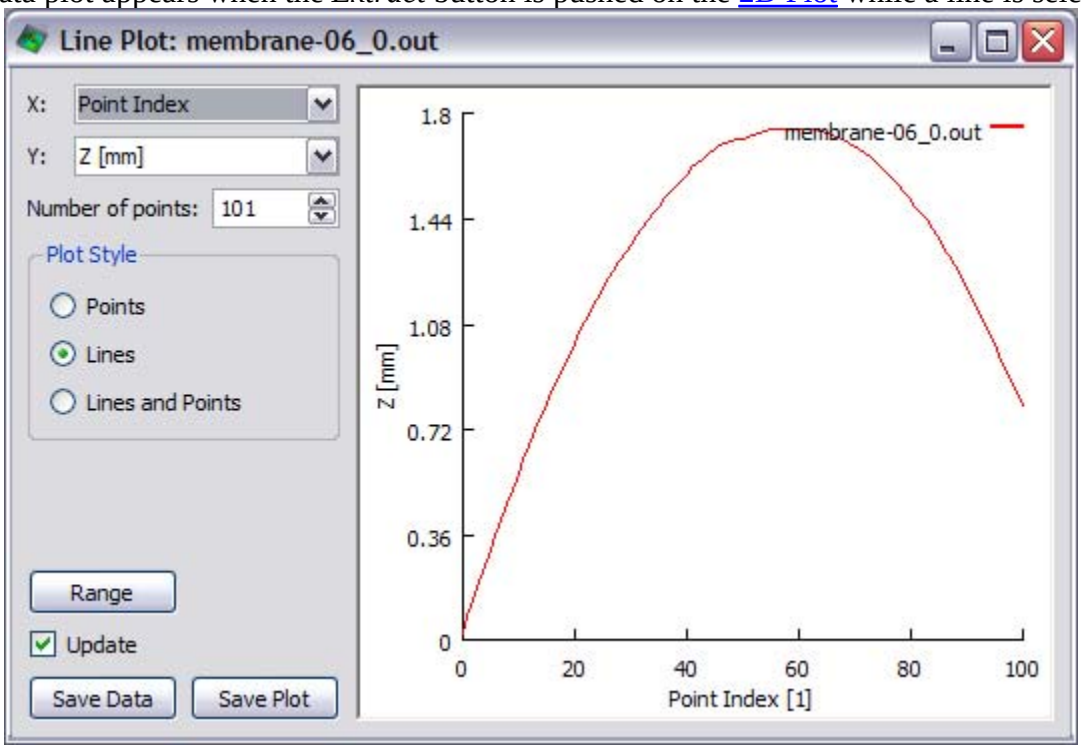
Line Plots

Line plots can be generated by using the Inspector Tools in a 2D plot. There are two types of line plots currently available:

- Data extracted along a line
- Data extracted from a sequence of data files

Line Data Extraction and Plotting

The line data plot appears when the *Extract* button is pushed on the 2D Plot while a line is selected:



Adjusting the Number of Data Points

The number of data points that are extracted from the data file along the line can be adjusted using the *Number of Points* control on the window.

Range

Click *Range* to select the x/y axis limits. To compute limits automatically (the default), click *Range* and select the *Auto-scale* checkbox.

Update

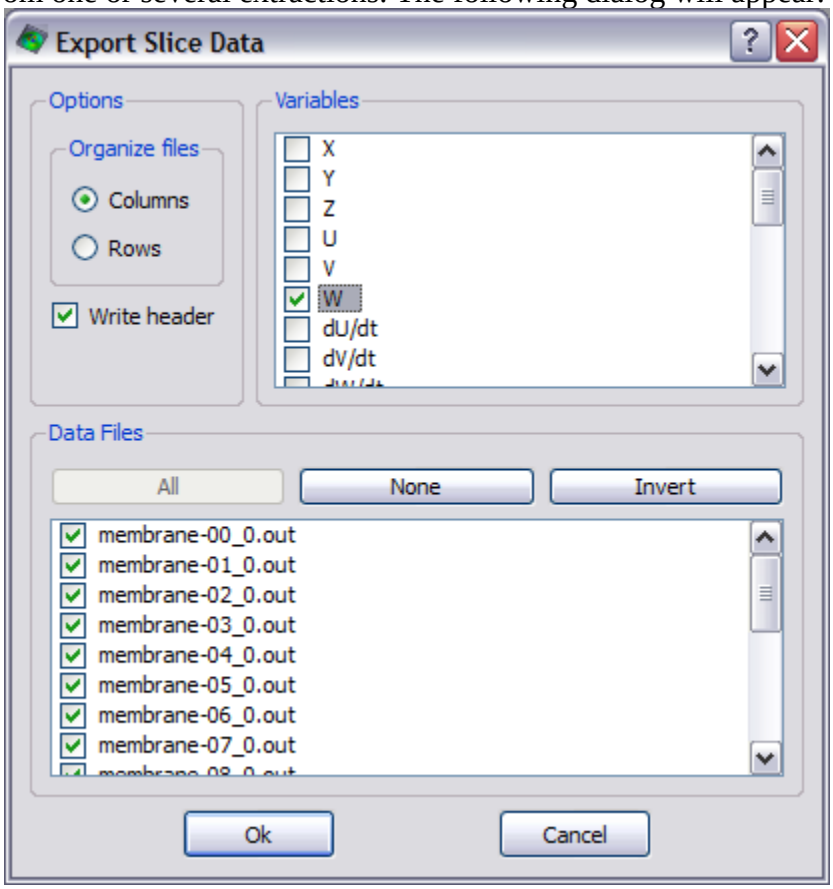
When the *Update* box is checked, the plot will update when a new file is selected in the Data tab..

Plot Style

The plot style can be selected to either show data points, lines or data points and lines.

Save Data

Click to save data from one or several extractions. The following dialog will appear:



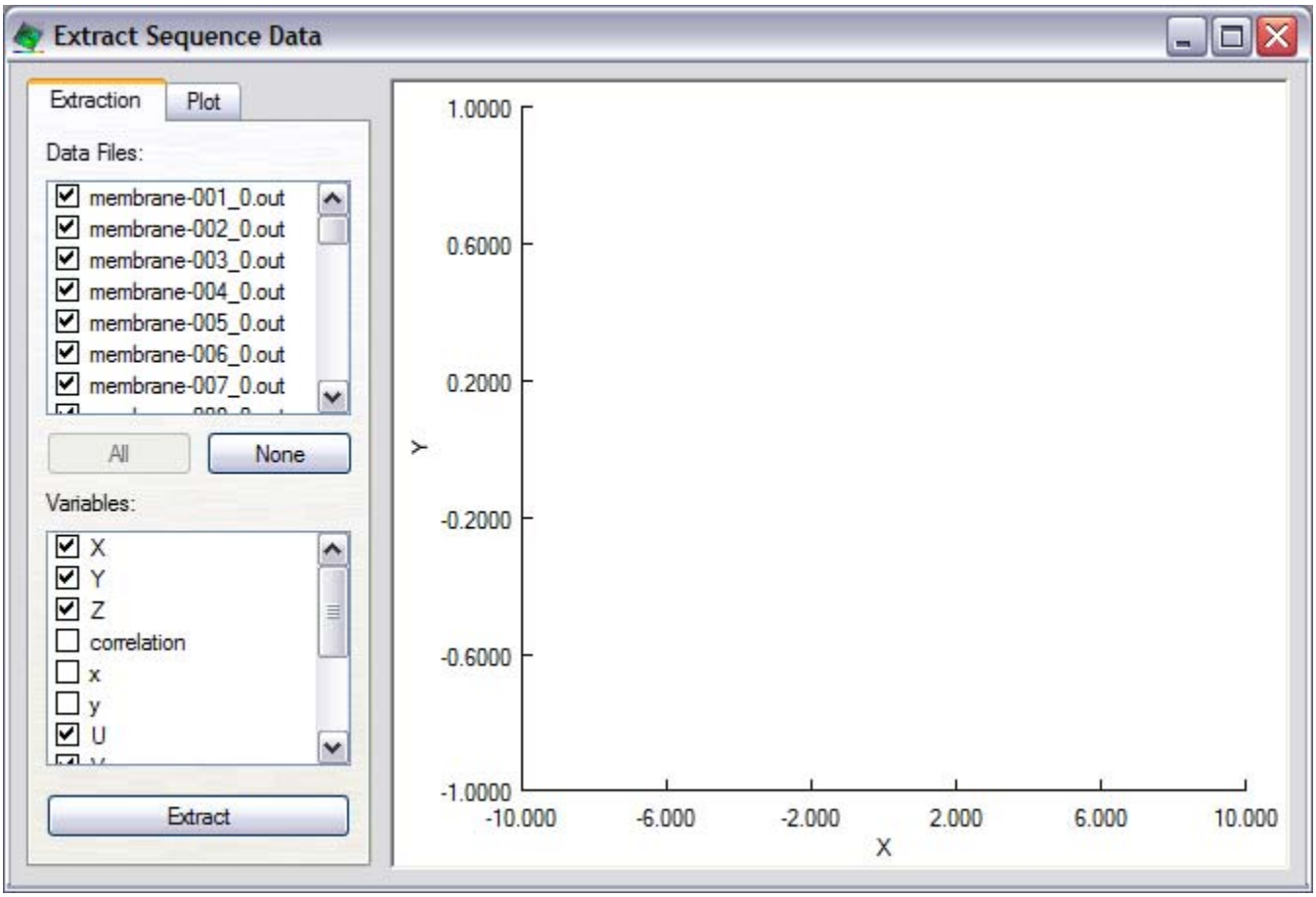
Select the variables to extract and the files to include in the extraction. The data may be organized by columns or rows; to include a row/column header which contains the name of the relevant data file, select *Write header*.

Saving Plots

The plot can be saved as a BMP, PNG, or JPG image file by pressing *Save Plot* in the bottom left of the plot window. You may also copy the plot to the clipboard by right-clicking on the plot area and selecting *Copy*.

Sequence Data Extraction and Plotting

The sequence data extraction window appears when the *Extract* button is pushed on the 2D Plot while a point, circle, or rectangle is selected:



Selecting Data Files

The data files used for extraction can be selected in the listbox in the top left of the window on the *Extract* tab.

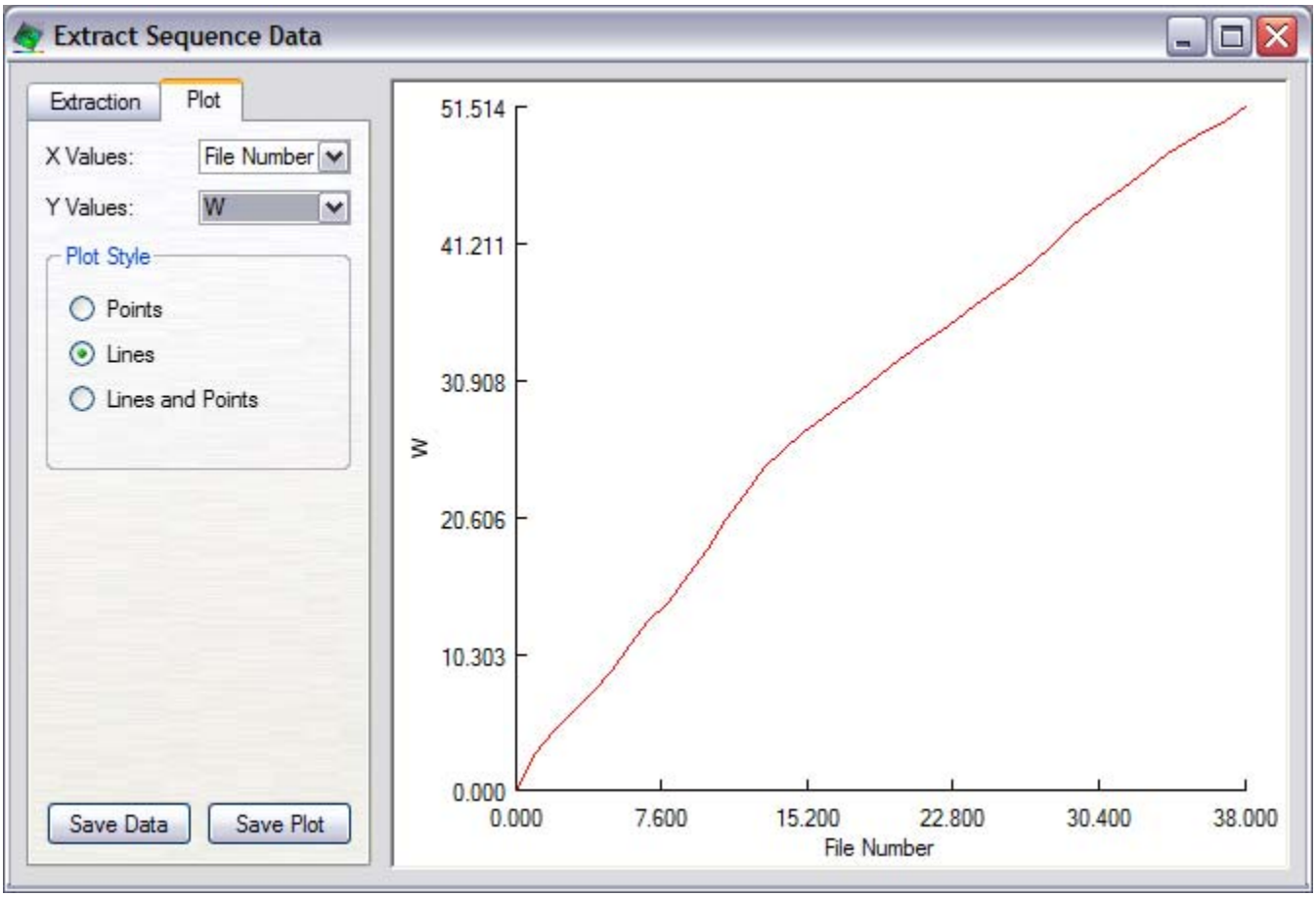
Selecting Variables

The variables to extract from the files can be selected in the listbox in the bottom left of the window on the *Extract* tab.

If an analog data file is present, time and analog data values may be selected for either axis.

Extracting the Data

After selecting the data files and variables to extract, push the *Extract* button to extract the data. Depending on the size and number of data files, this might take some time and a progress indicator will be shown to indicate the extraction progress. After data extraction, the *Plot* tab will become active and the window will appear as follows:



You can select from available variables for both X and Y axes. For an extensometer extraction, the available values will be D0 (initial distance), D1 (deformed distance), and E (strain). This is not a Lagrangian strain but only the first order change in length divided by initial length term.

Plot Style

The plot style can be selected to either show data points, lines or data points and lines.

Saving Data

The extracted data can be saved as a comma-separated variable file by pressing the *Save Data* in the bottom left of the plot window.

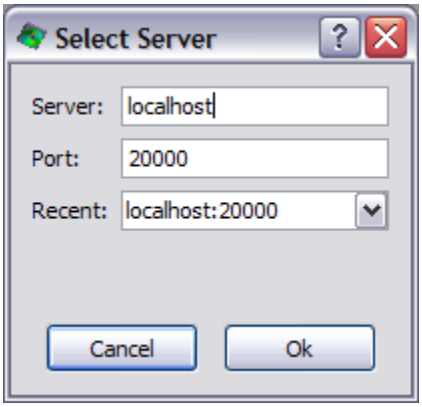
Saving Plots

The plot can be saved as a BMP, PNG, or JPG image file by pressing *Save Plot* in the bottom left of the plot window. You may also copy the plot to the clipboard by right-clicking on the plot area and selecting *Copy*.

Real-time Analysis

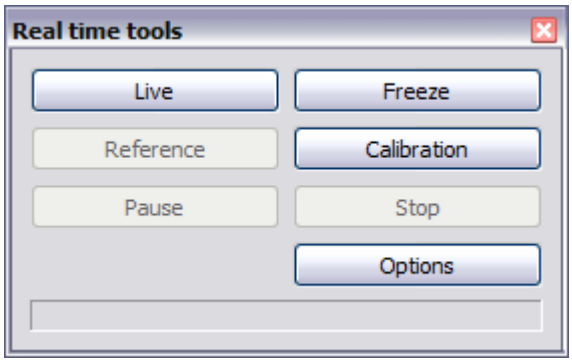
To enter real-time mode, first start start Vic-Snap and start the real-time server (see Vic-Snap documentation for details). Then, start Vic-3D and select *File... Mode... Real-time 3D Analysis*.

You will be prompted for a server address and port:



With Vic-Snap running on the local PC, select *localhost*; if Vic-Snap is running remotely, you may enter the IP address of the acquisition PC. The *Port* setting should be left at the default unless there is conflict.

Vic-3D will attempt to connect to the image server; when the connection is established, a live view will appear in the workspace, and the real-time tools will be displayed:



Calibration in real-time mode

Calibration must be performed outside of real-time mode. There are two possible routes:

- Calibrate in Vic-Snap. If a calibration is present in Vic-Snap when you start real-time mode, it will be transferred to Vic-3D, and will appear in the Calibration tab. Or, click *Calibration* in the tool set to transfer at a later point.
- Calibrate in Vic-3D. Before beginning the test, complete a standard calibration in Vic-3d, and save a project file. After entering real-time mode, select *Calibration... Import calibration*, and select the previously saved project.

Selecting a reference image

To select a reference, click *Reference* in the real-time tool set. The currently displayed live image will be copied and used as reference. You may draw AOI's on this image exactly as in the standard Vic-3D mode.

Running the analysis

To being the real-time analysis, click the green Start Analysis button in the toolbar, or select *Data... Start analysis*. Incoming images will be analyzed and transferred in sequence as fast as the processor and transfer speed allow.

Analysis options

Correlation options may be adjusted before or during the analysis. If the analysis is already in process, the changes will not take place until you restart the correlation.

Pausing the analysis

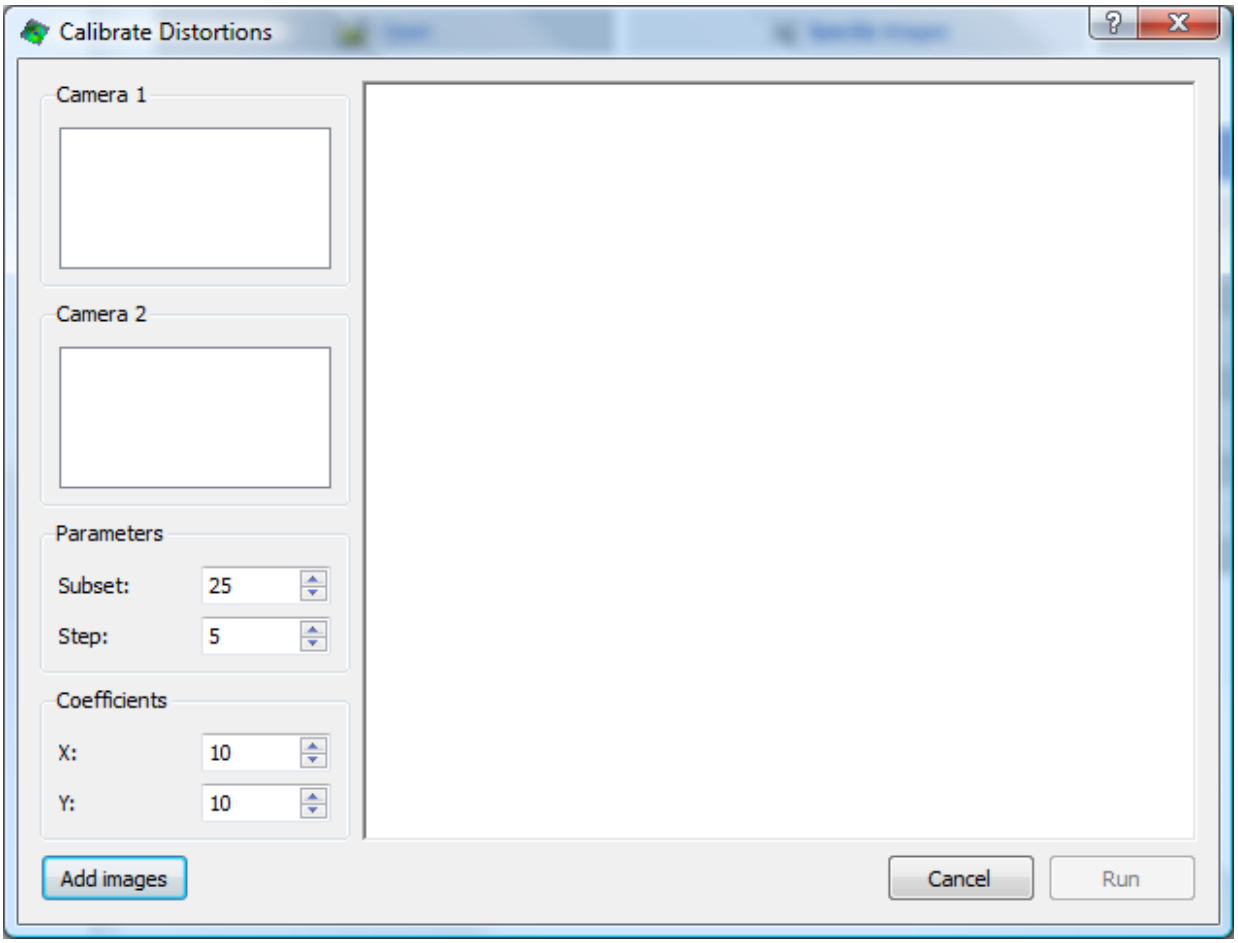
In order to make changes to coordinates and contour levels, it may be helpful to pause the analysis by clicking *Pause*. The button text will change to *Resume*; click to resume.

Notes

- The data analyzed in real-time mode is displayed but not saved. To allow later processing and storage of data, be sure to store the images in Vic-Snap as usual (timed capture, manual capture, etc.)
- To obtain the best frame rates in Real-time mode, select a large step size; this will result in fewer points being analyzed and more total updates per second.
- Select a desktop PC with 2, 4, or 8 cores for maximum analysis speeds. With a fast PC and a larger step size, frame rates of 5-10 per second can be realized.
- Real-time mode is available with an optional module.

Calibrating distortions

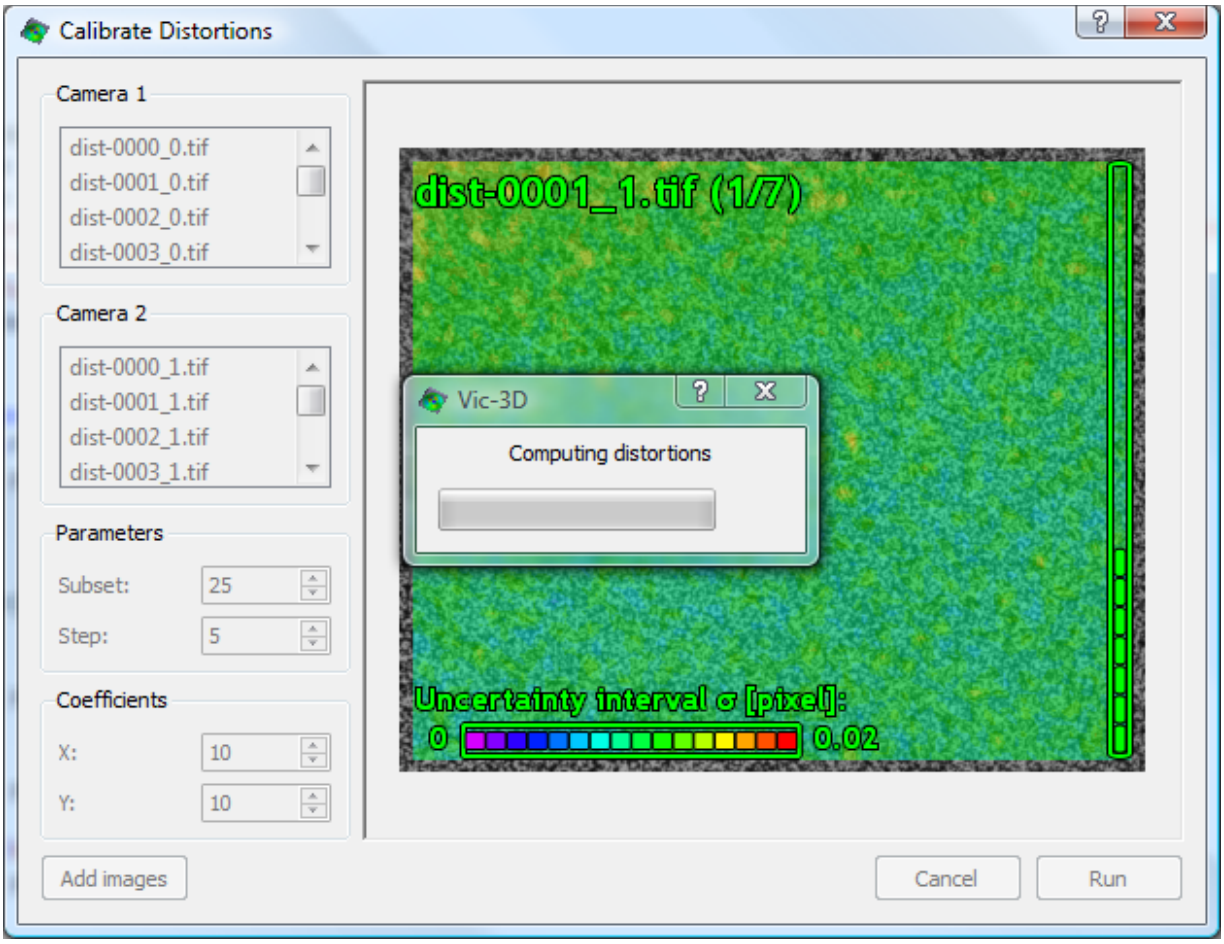
To calibrate a stereo-microscope, start by selecting Stereo-microscope mode in Vic-3D (File... Mode... Stereo-microscope). The following dialog appears.



Adding translation images

Add translation image pairs by clicking **Add images**. Select the desired images and click **Open**.

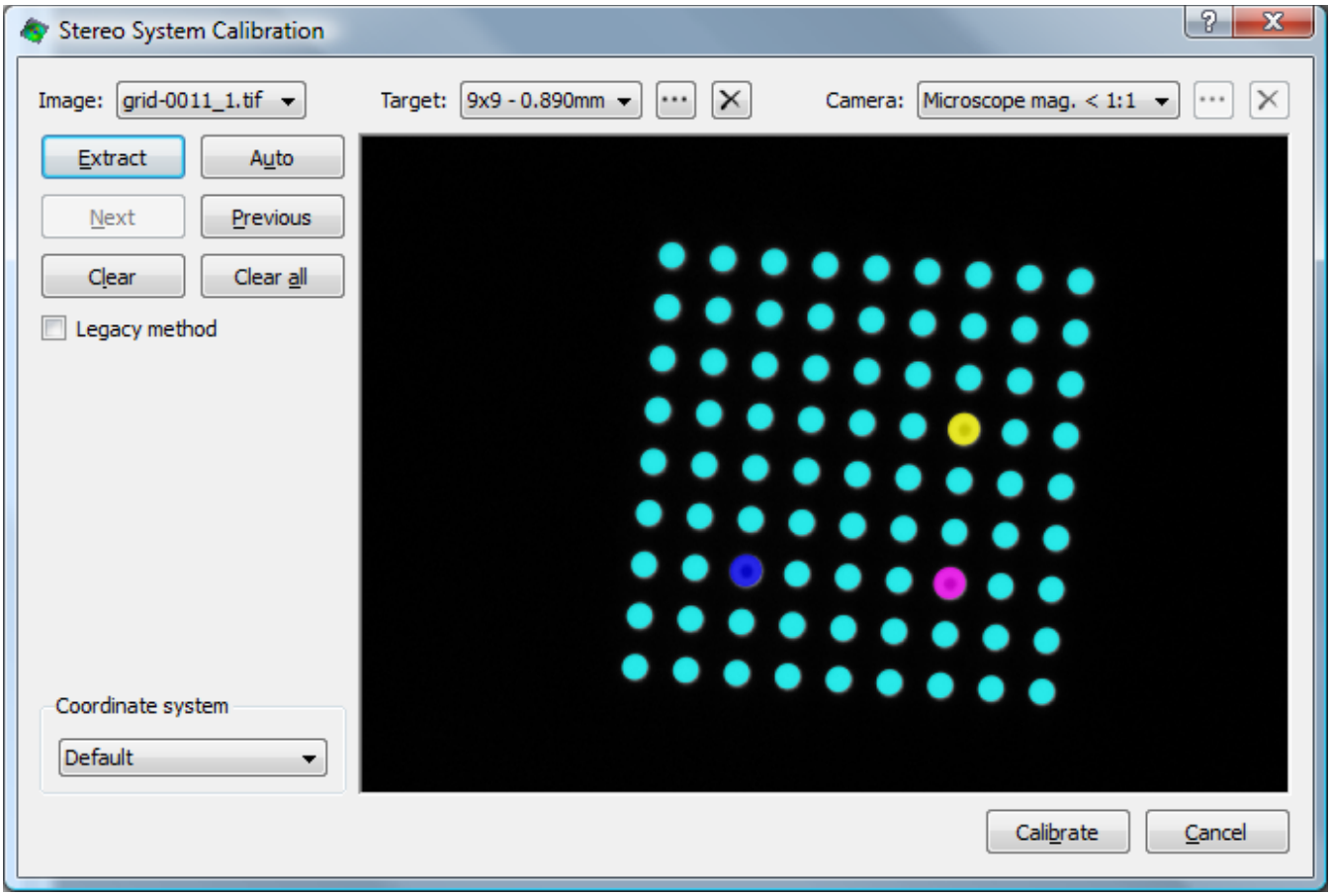
Select a Subset size that is appropriate to the speckle image. For most situations, the Step and Coefficients settings can be left as is. Click **Run** to begin the analysis.



When analysis is complete, a message indicating success or failure will appear. Click to continue, and save the project to store the distortion correction map.

Stereo calibration

Once the distortion correction is complete, you can add stereo grid images and calibrate as usual. The distortion order is not selectable as the distortion is corrected by the inverse mapping function.



For the *Camera* pulldown, you must select whether the magnification of the system was greater than or less than 1:1. Selecting the wrong option will result in an inverted Z-axis.

Analyzing speckle images

Once the distortion and grid calibration is complete, you can add and analyze speckle images as usual. The data will be processed using the distortion map and corrected.

Quick Start

There are only a few steps involved in obtaining shape and deformation measurements from your images. If you are using Vic-3D for the first time, take a look at the example provided with the program. Then, try to go through the following steps yourself to quickly familiarize yourself with the program usage:

1. Add your calibration images to the project.
2. Perform the calibration.
3. Add a reference image and select your area of interest.
4. Add more speckle images, if applicable.
5. Run the correlation analysis.
6. Plot the results

If you encounter any difficulties, please do not hesitate to contact our technical support department .

What's New in Vic-3D 2010

- Completely new tools for drawing AOI's and setting up initial guesses.
- Uncertainty measures available for position and displacement data.
- Improved parallelization for taking even better advantage of multi-core processors.
- New equation editor with user-selectable constants.
- User interface redesigned for increased ease of use.
- Regenerate your original data at any time with the "Retriangulate" function.
- Calibration process has been streamlined and simplified.
- Strain calculation is now quicker and more accurate.

Transitioning from older Vic-3D versions

For users transitioning from Vic-3D 2007 and 2009, the most visible differences will be in the areas of AOI creation, and calibration.

- When creating AOI's, a seed point is no longer automatically placed. In most cases, you can simply draw your AOI and then run your analysis. Where a seed point is required, you can place one or multiple start points.
- In the 3D calibration dialog, you will simply pick your target, and then click Analyze. The rest of the process happens automatically. To remove bad images, you can right-click directly on the score.

Important note: Projects may be loaded from any earlier version of Vic-3D. However, projects saved in Vic-3D 2010 can only be loaded in Vic-3D 2010. These projects contain detailed information about settings and calibration so that you may exactly reproduce project data without having to recall thresholds and correlation settings.

Some other changes that existing Vic-3D users may want to explore:

- The equation editor has been revamped completely. Save and load constants, and use analog data within your equations.
- In past versions, if you applied too many transforms or otherwise modified data, the only way to get the original data back was to rerun the correlation. Now, you can use the "Restore data" option to retriangulate the original data very quickly.
- You can now add true metric confidence data to your correlation results. Just check the "Compute confidence" margins checkbox in the Post-Processing tab of the Run Dialog. You will see three new output variables representing the 1-standard-deviation confidence for each axis, in mm.
- Images are compared to each other using a different scheme than in prior versions. This will increase robustness and quantity of results in many cases.

Technical Support

If you cannot find an answer to your question in this manual, please do not hesitate to contact our technical support at support@correlatedsolutions.com. You can also find contact information at our web site at www.correlatedsolutions.com.

We will be happy to assist with topics such as:

- Designing digital image correlation experiments
- Calibration
- Troubleshooting errors
- Interpreting test data
- Achieving optimal results

Bug Reports and Feature Requests

If you encounter a bug in Vic-3D, please let us know about it. Send a short description of the problem to support@correlatedsolutions.com, along with any project or image files you think may help us reproduce the bug.

Also, if you think Vic-3D can be improved by adding a particular feature you would find helpful, let us know about it. We will try to incorporate your requests in our future updates of the software.